CHAPTER 2

COMPUTER CONFIGURATIONS AND HARDWARE

INTRODUCTION

As a technician you must be able to recognize the different types of computers to maintain them. The functional units of any computer are consistent, no matter what type of computer you are maintaining. Your main concern will be the architecture of the computers you maintain. Mainframe computers and minicomputers are usually housed in large- to medium-sized frames or cabinets suited for ruggedness. Microcomputers are housed in compact frames built more for their portability. If you can understand the architecture and general physical makeup, then you can maintain any type of computer. Technical manuals, owners' manuals, desktop guides, and system operating manuals are all excellent sources of information that you can use to learn the configuration of a specific computer system and its physical makeup.

After completing this chapter, you should be able to:

- **Interpret the various types of diagrams and layouts used to specify unit configurations**
- **Describe the major hardware parts of a computer system**
- **Describe the unit connectors and cables of computer systems**
- **Describe the types of cooling systems used with computers**

TOPIC 1—COMPUTER CONFIGURATIONS/LAYOUTS

To be an effective technician, you must be familiar with the computer-inside and out. You must be able to understand the hardware as well as each of the functional units by using technical documents. The computer's technical manual will be your most reliable and effective source. Technical manuals usually start with a general description of the computer and become more detailed when discussing the hardware and each functional area of the computer. As a reminder, you must ensure you use the most current documentation when you perform maintenance on a computer. This is a **MUST.**

In our discussion of the computer in this topic, we examine the computer from two aspects—the functional layout and the physical layout. Let's begin by examining how computers are functionally configured.

FUNCTIONAL BLOCK DIAGRAMS OF COMPUTERS

A functional block diagram provides you with a general analysis of the principles of operation of the overall equipment, types of signals and their directional flow, and the major functional areas. Functional block diagrams can be of two types—the **overall functional block diagram of the computer** and the **individual functional block diagrams of each functional unit.** You can use both to gain a better understanding of the computer.

Overall Functional Block Diagrams

Overall functional block diagrams will show the functional areas of the computer and the supporting functions, such as power, cooling, and control of the computer. They will also show the types of signals exchanged between the functional areas and the supporting functions and the direction of signal flow. Figure 2-1 is an example of an overall functional block diagram of a computer.

Overall functional block diagrams are very useful when you perform corrective maintenance. After you have identified and elaborated on a problem, you can use the overall block diagram for the **"listing of probable faulty functions."** This will help you in your next step in the troubleshooting process— **"localizing the faulty function."** The overall functional block diagram can help you stay in the right area when troubleshooting.

Individual Functional Block Diagrams

Once an overall description has been presented, the technical manual will give a general description of each functional area separately. These will include the major functional areas (CPU, I/O, and memory); the supporting functional areas (power supply and any special cooling requirements); and control of the computer (maintenance console/panel or display control unit and remote console/panel). When each functional area is described individually, an accompanying functional block diagram of that area will follow. Individual functional block diagrams can help you in your troubleshooting once you have "localized the faulty function." They provide a more detailed analysis of how that specific area of the computer operates. See figure 2-2 as an example of an individual functional block diagram of a CPU.

FUNCTIONAL LAYOUTS OF COMPUTERS

Functional layouts will show the major functional areas of the computer—CPU, I/O, and memory. Figure 2-3 is an example of an individual functional layout for a basic single cabinet configuration.

Systems that use a multiple configuration with more than one computer will also be depicted using an

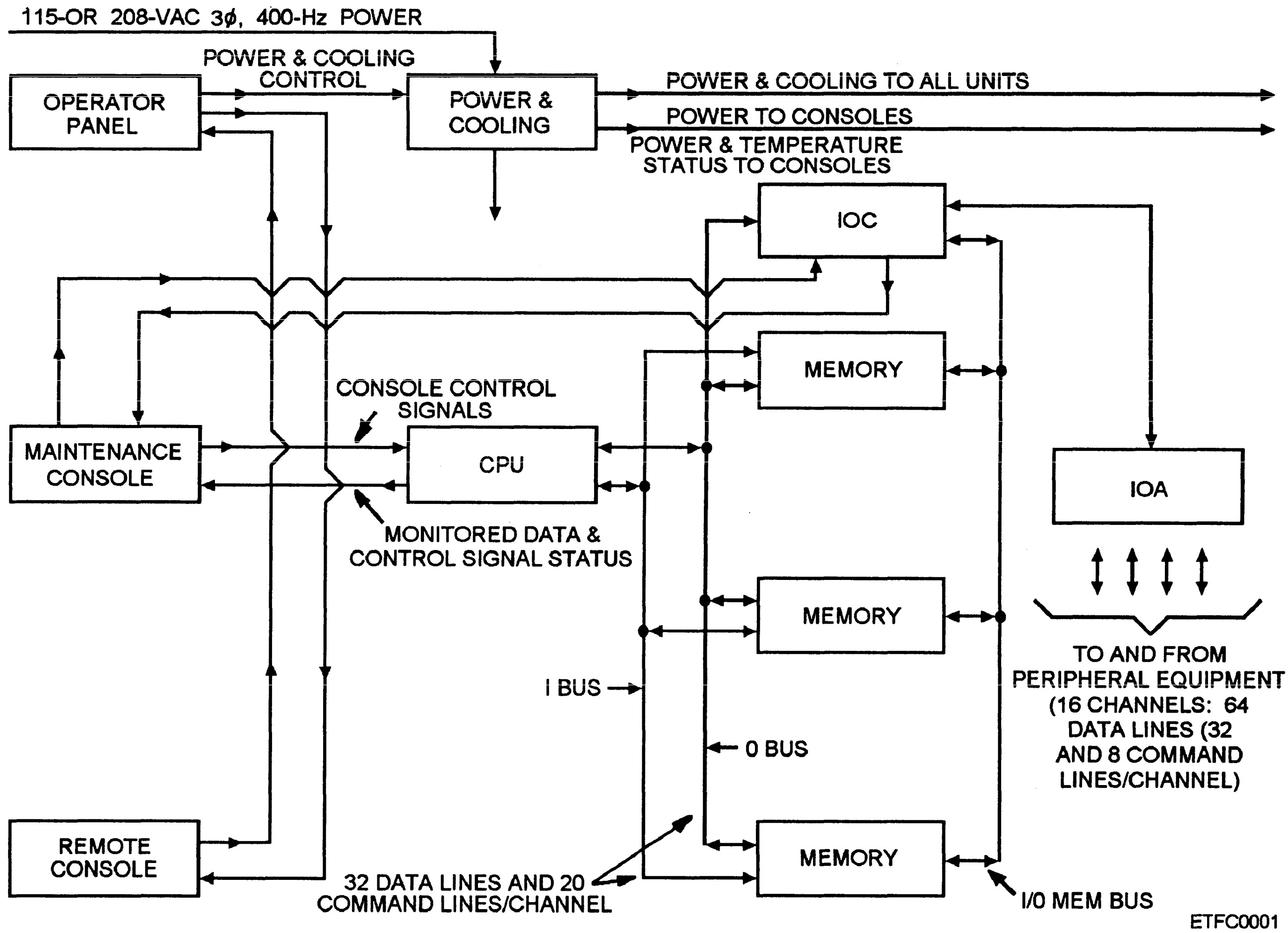

Figure 2-1.—Example of an overall functional block diagram.

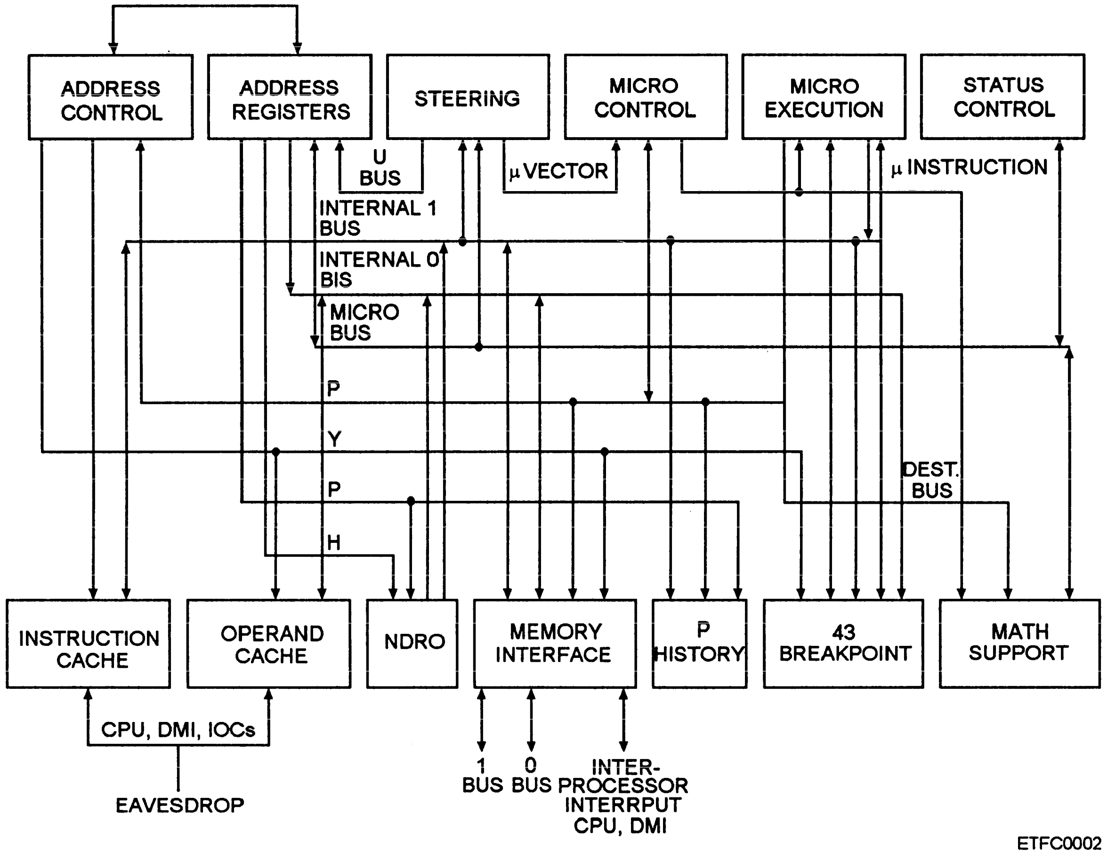

Figure 2-2.—Example of an individual functional block diagram of a CPU.

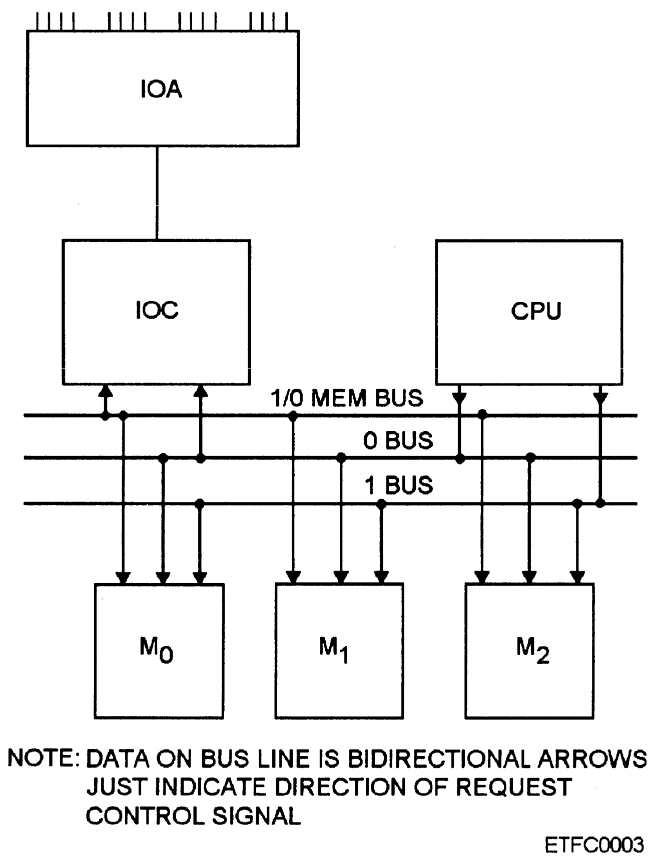

Figure 2-3.—Example of an individual functional layout of a single cabinet configuration.

overall functional layout. Figure 2-4 is an example of a functional layout of a multiconfiguration computer system.

PHYSICAL LAYOUTS OF COMPUTERS

Physical layouts provide you with a "picture" of the computer. They are designed to show what the computer looks like and where each assembly, module, or console (maintenance and operator) of the computer is located. Physical layouts do NOT depict detailed descriptions of signal flow. Let's take a look at some of the ways computers are physically laid out.

Overall Physical Layout of Computers

Overall physical layouts will show you where each of the major parts of a single computer/computer set is located. The physical layouts and the terminology will vary with the type of computer and the manufacturer. The technical manual of each computer will provide you with the physical layout of that computer. Let's take a look at four types of physical layouts—modular, chassis or assembly, cage or rack, and motherboard or backplane.

MODULAR.— The functional areas of the computer are modularized. In other words, the functional areas only contain the hardware for the function specified. For example, the module designated as the CPU only contains the subassemblies or printed circuit boards for the CPU functions. Figure 2-5 is an example that depicts the physical layout of a single mainframe computer set. Notice the modular layout. Also keep in mind that data systems that employ a multiple configuration will depict the minimum physical layout configuration AND the full physical layout configuration.

CHASSIS OR ASSEMBLY.— Chassis or assemblies usually are door mounted or slide mounted. Computers that use chassis or assemblies may contain one or more chassis or assemblies for the whole system. For example, one chassis may be dedicated only for memory, one for the power supply, and a third chassis or assembly for the rest of the computer (the CPU and the I/O). One to several subassemblies or printed circuit boards (pcb's) may comprise the CPU, I/O, or memory. Figure 2-6 is an illustration of a chassis used in a minicomputer.

CARD CAGE OR RACK.— A card-cage or rack-designed computer will generally contain the major functional areas of a computer. The card cage or rack is usually centrally mounted in the overall computer chassis. The number of subassemblies or pcb's contained in a card cage or rack can vary from just a few to many depending on the technology of the computer. One or more pcb's may comprise a functional area. A card cage or rack is fixed in a single position; it does not slide out or swing open like a door.

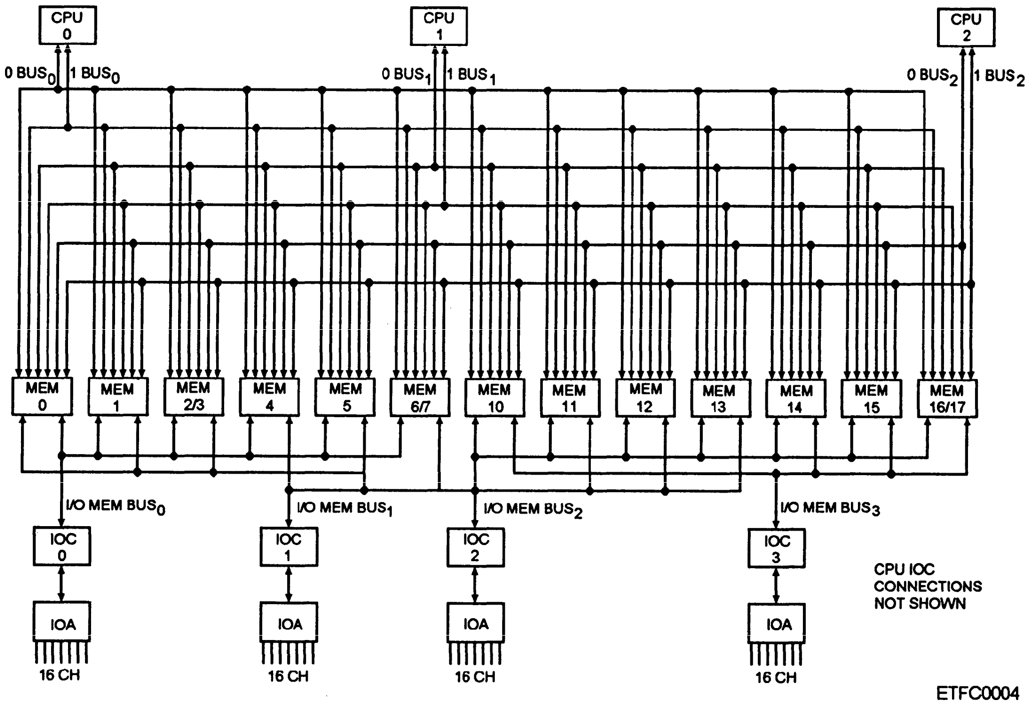

Figure 2-4.—Example of a functional layout of a multiconfiguration computer system.

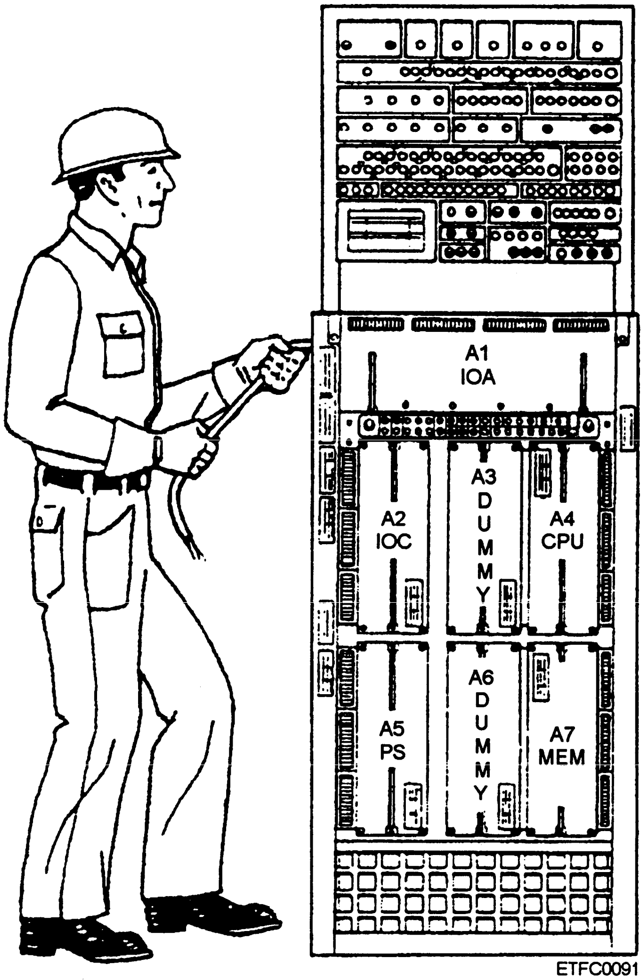

Figure 2-5.—Physical layout of a single mainframe computer set.

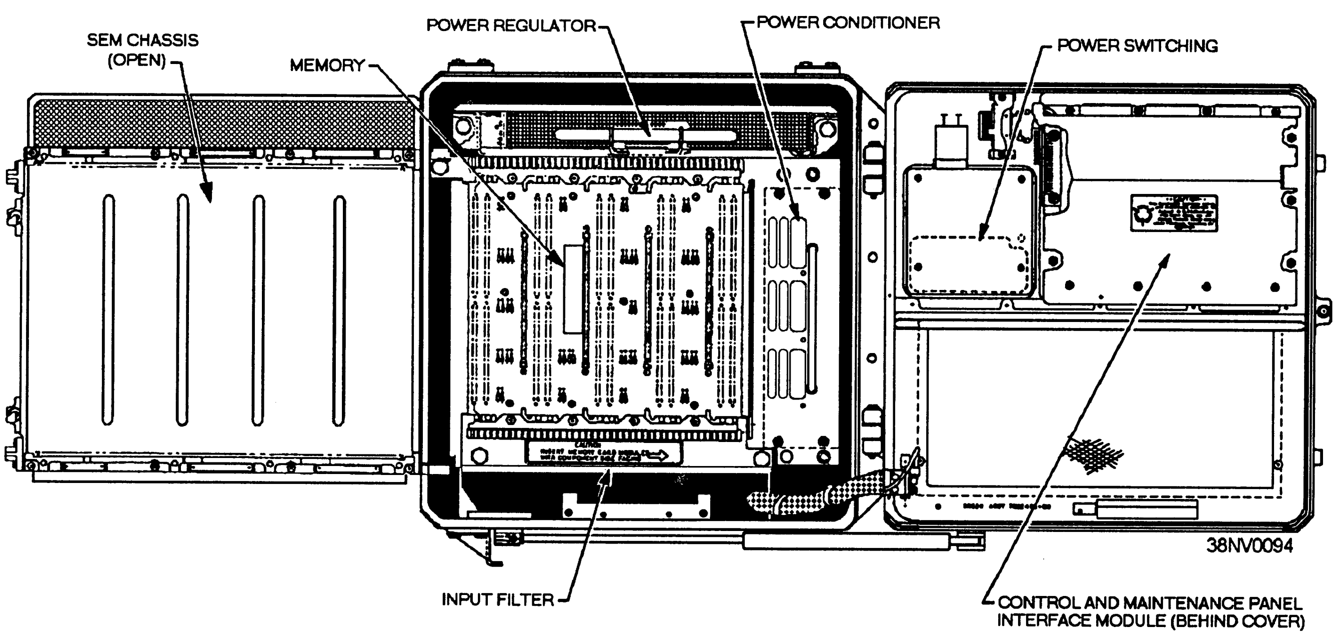

Figure 2-6.—Example of a chassis used in a minicomputer.

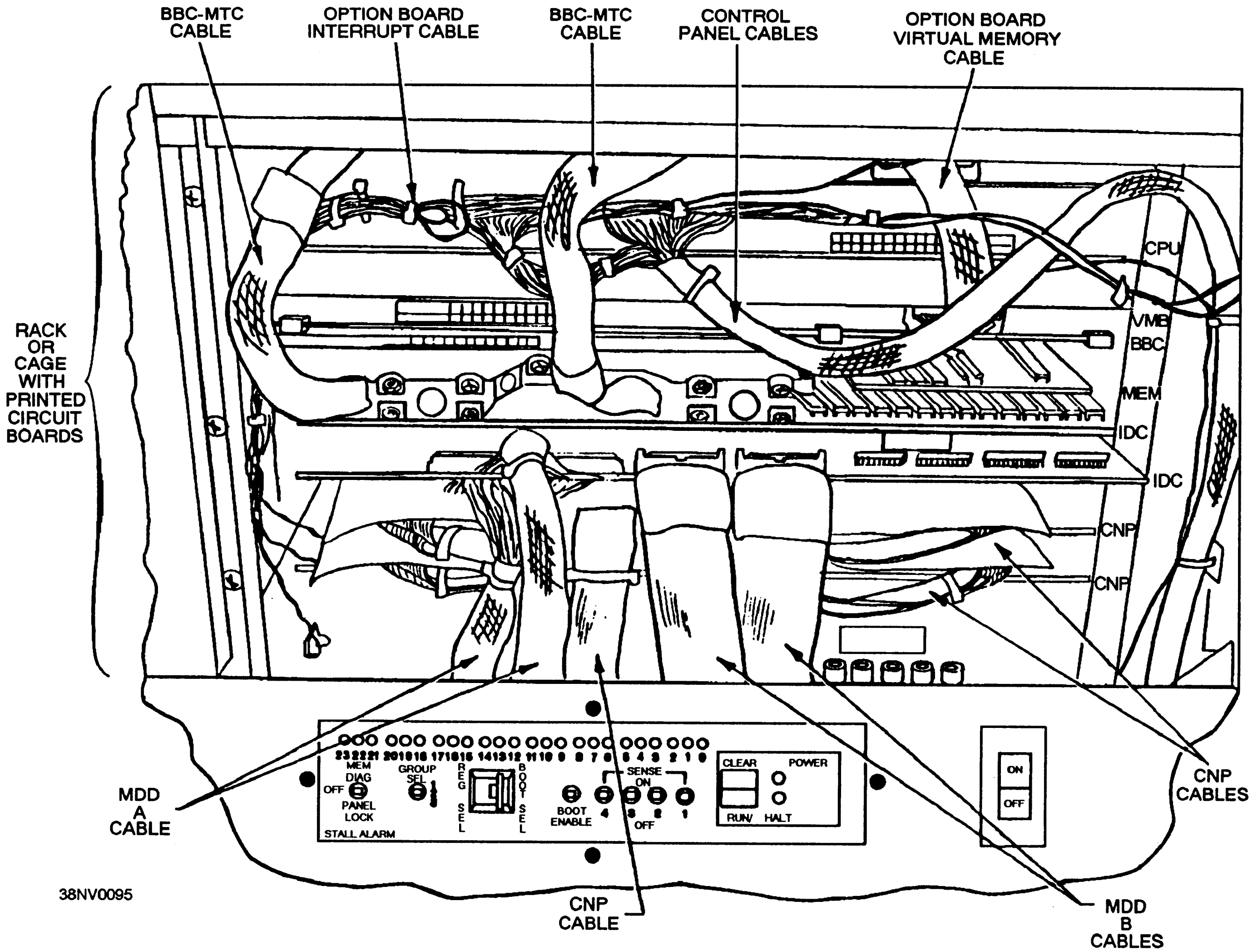

Figure 2-7.—Physical layout of a card cage or rack used in a minicomputer.

Figure 2-7 is an example of a card cage or rack used in a minicomputer.

BACKPLANE OR MOTHERBOARD.— Backplanes or motherboards are stationary and are generally located inside the computer's chassis. In this arrangement, all the subassemblies or pcb's needed to run the computer are contained on a single backplane or motherboard. The number of fictional areas contained on a single subassembly or pcb may vary according to the technology of the computer. Computers that use a backplane or motherboard are compact. Figure 2-8 is an example of a backplane used in a microcomputer.

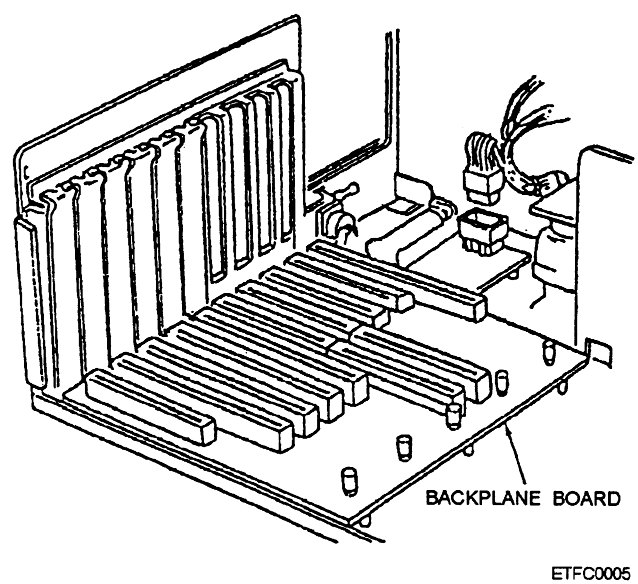

Figure 2-8.—Example of a backplane used in a microcomputer.

Individual Physical Layouts of Computer Parts

Using individual physical layouts, the technical manuals depict each part of the computer separately. By separating each major part of the computer, you can break down the computer from a whole unit to the frame/cabinet to see how subassemblies or printed circuit boards are laid out in each assembly, chassis, or module. Check your computer's technical manual for specific details.

Examples of the parts of a computer that are depicted in individual physical layouts are the following:

- Maintenance and operator console/panel location and its identification of individual computer controls
- Display control unit location and identification of its individual controls
- Remote console/panel location and identification of its individual computer controls
- Mainframe or cabinet and its contents
- Assemblies or chassis and their contents
- Subassembly or printed circuit card locations and their component locations

Figure 2-9 is an example of an individual physical layout of a module used in a mainframe computer. Notice how the contents of the module are physically laid out.

For some computer units/parts, individual physical layouts are not provided in the technical manual. For example, a layout would not be provided for a power supply in a microcomputer that is sealed. You only need to determine that the power supply has a faulty output and turn the power supply in for a replacement. If you never have a reason or are never required to open a unit/part to repair it, there is no need to have an individual physical layout.

We have discussed unit configurations, now let's focus our attention on the hardware of a computer. We start with the frame/cabinet, some of the parts that are contained in a frame/cabinet, computer connectors, cables, and finally computer cooling hardware.

TOPIC 2—COMPUTER HARDWARE

The hardware makeup of each computer will vary. Generally speaking, the type of computer and platform of the data system will dictate the physical makeup of the computer. Large computers tend to be more rugged and the modules or assemblies more tightly assembled than a microcomputer (PC), which is generally more adapted for portability and not for ruggedness. Let's take a look at some of the hardware used in computers.

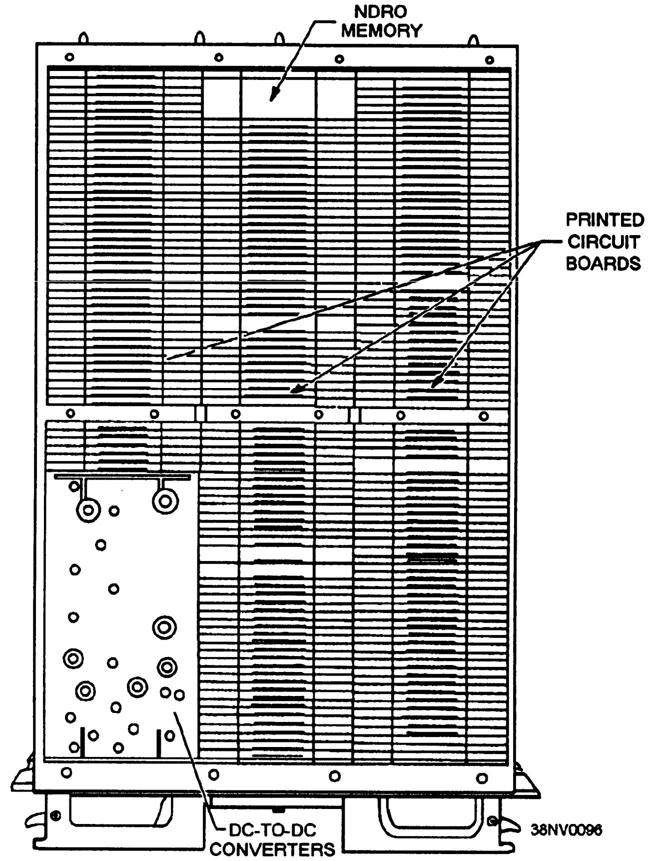

Figure 2-9.—Example of an individual physical layout of a module used in a mainframe computer.

We'll start with the frame or cabinet and work our way down to the pcb's, subassemblies, and the support hardware.

COMPUTER FRAMES/CABINETS

The frame or cabinet (often called the chassis) houses the computer. It holds or supports all the parts (the functional areas) of the computer. As you will see there are different designs based on the different types of computers and the types of systems on which they are used. These dictate the type of arrangement the frame or cabinet has. In most cases, the frame or cabinet also contains the support areas-the power supply module or unit and hardware for cooling.

The frame or cabinet can provide limited protection for the computer against such hazards as shock, moisture, and EMI or RFI. As a general rule of thumb, except for PCs, all computers aboard ship are shock mounted to withstand the constant motion of the ship as well as sudden impact. For computers that are used ashore, the frame or cabinet is secured to the floor. The size of the frame or cabinet of a computer is a general indication of the type of computer and the type of data system the computer is used on. Consult your computer's technical manual or owner's manual for parts, tools, and test equipment needed in the maintenance of the computer.

Let's take a look at the designs or types of frames/cabinets—modular, chassis or assembly, cage or rack, and motherboard or backplane. Some computers use combinations of these designs.

Modular-Designed Computer Frames/Cabinets

A frame or cabinet of modular design uses the concept that a functional area maybe composed of one module or several modules. An example of several modules that comprise one functional area is memory. It may take four modules to make up one functional area, memory. Modular frames or cabinets contain the following:

- External connections for data, control, and I/O cables
- Modules with test blocks on some types of computers
- Module mounting slides and retaining hardware
- Module electrical connector receptacles and interconnecting wiring harness
- An operator's control panel
- A blower unit and a system of air ducts allowing cooling air to circulate through all module heat exchangers
- Gaskets for electronic shielding, moisture protection, air ducting, and electrical connectors
- Filters for electronic shielding

Each module is made up of subassemblies and/or pcb's and a heat exchanger for air-to-air cooling. Modular-designed computers that are watercooled will have the necessary hardware fixtures for liquid cooling. A maintenance panel can be located up to 15 feet from the frame or cabinet that houses the functional areas or it may be affixed over the top of the frame or cabinet. In the modular setup, the power supply will be contained in a module just as the major functional areas are. Figure 2-10 is an illustration of a modular setup used in a large mainframe computer.

The modular-designed frame or cabinet is the most rugged. Each module fits into a compartment. The modules slide into the compartments of the frame or cabinet and are secured with retaining hardware to prevent the module or assembly from sliding back out. At the rear of each compartment of the frame or cabinet for each module, there is an electrical connector receptacle for data and power. The receptacle is keyed so the module can only go in one way. You must secure the power when removing and replacing a module or to gain complete access to all the subassemblies or pcb's inside a module.

Each module contains all the electronic parts and circuitry that make up one functional area or a portion of a functional area. Examples of modules used in a modular design of a large mainframe computer are the CPU, I/O, memory, and power supply. The CPU usually consists of only one module, whereas the memory of a computer may require multiple modules to form the memory. Each module will consist of electronic subassemblies and/or printed circuit boards that are color coded for easy identification. The printed circuit boards will fit into keyed slots that are in close proximity to each other. In this way one module can hold over 200 pcb's. The pcb's are configured in rows. Check the computer's technical manual for the chassis map of the pcb's and other major subassemblies. Refer back to figure 2-9 for an illustration of a module with the cover removed.

Other items found on a module are test blocks for maintenance, a time meter to monitor powered-on time, gaskets for electronic shielding, and a heat exchanger for cooling. The functional areas that are basic to most modularly designed computers include the following:

- Central processing unit (CPU)
- Input/Output controller (IOC)
- Input/Output adapter (IOA)
- Memory
- Power supply

Chassis- or Assembly-Designed Computer Frames/Cabinets

The design concept of computers that use the chassis or assembly arrangement is for the whole computer system to be located on one or more chassis or assemblies. Chassis- or assembly-designed computers are smaller than modular frame or cabinet housed computers, but they are also very rugged.

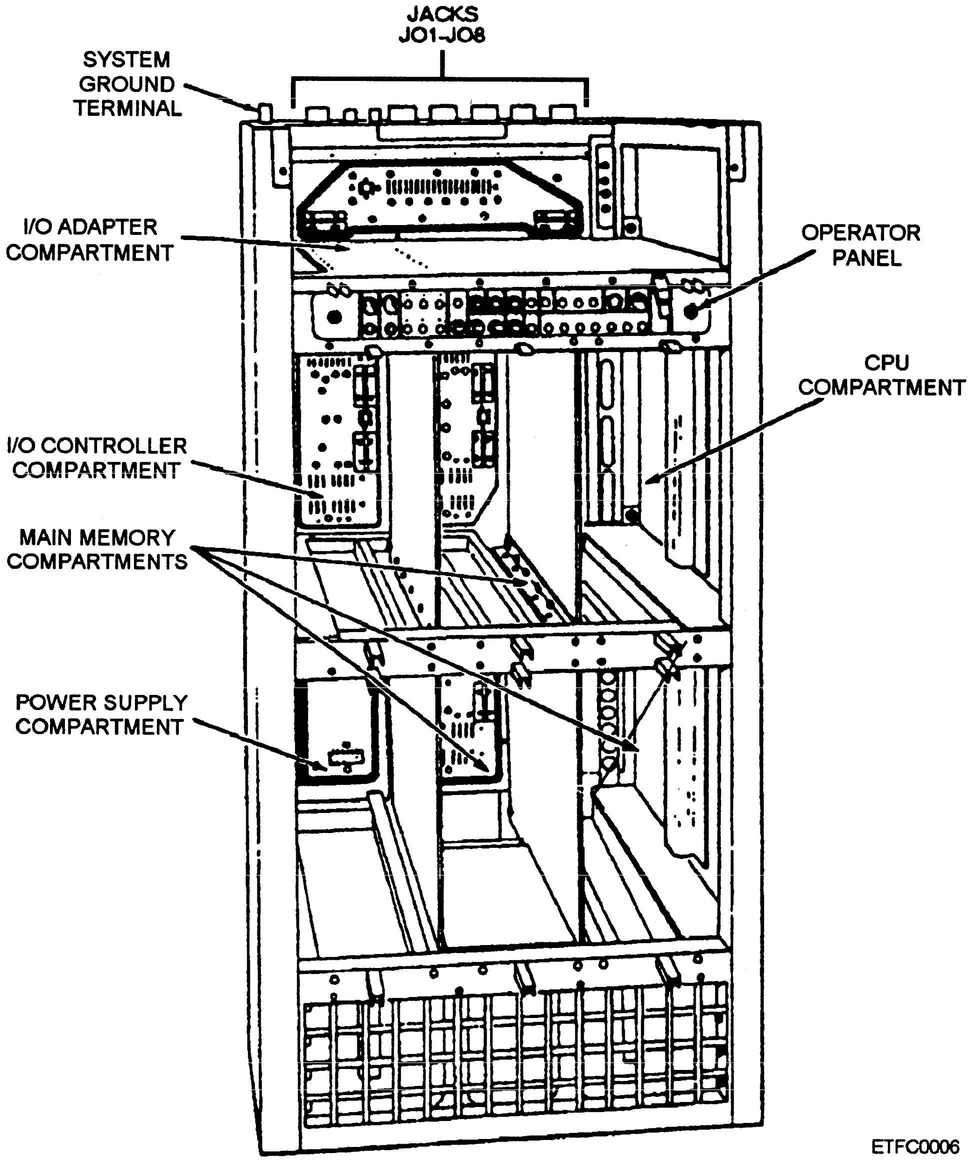

Figure 2-10.—Example of a modular-designed frame computer.

The chassis- or assembly-designed computer contains the following:

- Chassis or assemblies
- Chassis or assembly mounting and retaining hardware
- Chassis or assembly electrical connector receptacles and interconnecting wiring harness
- External connections for data and power cables
- Printed circuit boards (pcb's)
- An operator's control or maintenance panel
- A blower unit with air filter and heat exchanger, which allows cooling air to circulate through all the chassis or assemblies inside the frame or cabinet
- Gaskets for electronic shielding, moisture protection, air ducting, and electrical connectors
- Filter unit for electronic shielding
- Test blocks for maintenance
- Time meter to monitor powered-on time

Chassis or assemblies use the same basic concept as modules except they are not readily removable and usually contain more than one functional area of the computer. The functional areas are usually grouped together in blocks of two or more pcb's. The subassemblies or pcb's that make up a functional area are grouped together in a chassis or assembly rather than having a single module dedicated to one specific functional area.

The chassis or assemblies can be mounted in one of several ways inside the computer's frame or cabinet. These include brackets that permit the chassis or assembly to slide in and out of the frame or cabinet; doors that swing out from one side of the frame or cabinet; or a fixed chassis or assembly similar to a cage or rack inside the frame or cabinet. In some cases, a combination of two or more of these methods is used by a single computer. Chassis can slide out on mounting hardware, swing open like a door, or be fixed. Figure 2-11 is an illustration of a chassis or assembly-designed computer.

The pcb's inside a chassis or assembly are arranged in the same way as inside a module-in close proximity and configured in rows. Again refer to the computer's technical manual for a chassis map that outlines the location of all parts of the computer.

Each chassis or assembly contains subassemblies, pcb's, and a power supply unit. Some computers use small brackets to secure the subassemblies or pcb's inside each chassis or assembly. Each chassis or assembly is secured with retaining hardware. Check the computer technical manual to see if you can leave the power on while the assembly or chassis is extended or is being extended; it varies with the computer. This will affect the ability to extend subassemblies or pcb's on an extender card with the power on.

Support functions, such as power supplies and blower units, for chassis- or assembly-designed computers are usually located on a fixed chassis or assembly in the computer's frame or cabinet. Chassis- or assembly-designed computers can also be water cooled.

The functional areas that are basic to most chassis- or assembly-designed computers include the following:

- Central processing unit
- Input/output controller
- Input/output adapter
- Memory
- Power supply

Cage- or Rack-Designed Computer Frames/Cabinets

Computers that use cages or racks contain the following:

- A cage or rack

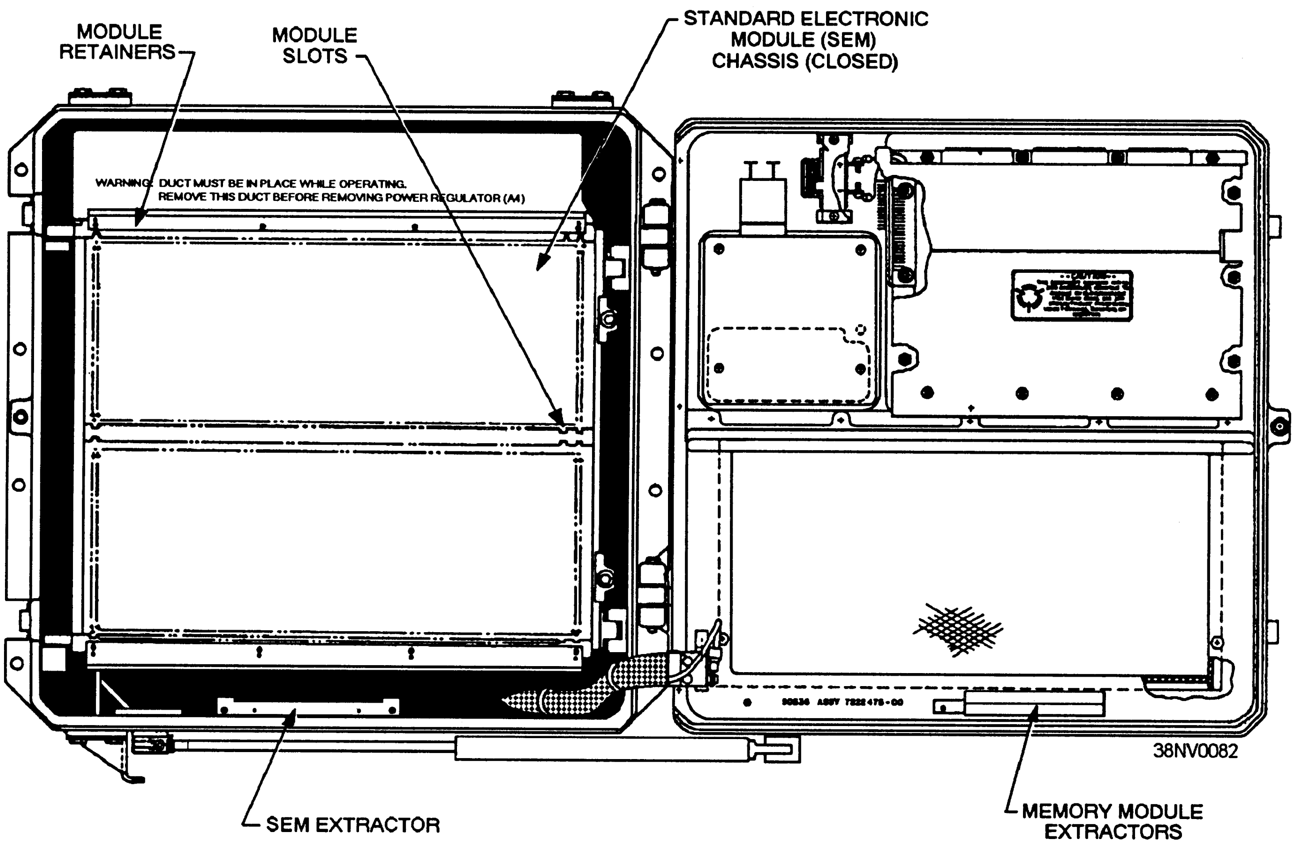

Figure 2-11.—Example of a chassis- or assembly-designed computer.

- Subassembly or pcb mounting slides and retaining hardware
- Subassembly or pcb electrical connector receptacles and interconnecting wiring harness
- Printed circuit boards
- External connections for data and power cables
- An operator's control or maintenance panel
- Power supply unit
- Blower unit
- Air filter

In a cage or rack arrangement, only the functional areas of the computer are contained in the cage or rack. The cage or rack contains pcb's that only house the major functional areas, such as CPU, memory, and I/O. Sometimes more than one functional area will be contained on a pcb. The pcb's slide into slots inside the cage or rack. The connector receptacles for each subassembly or pcb are usually located at the rear of the cage or rack. The pcb's are not always keyed, so you must exercise care when installing them. The pcb's are secured in each slot by retaining hardware. The cage or rack is generally fixed and cannot be extended as a whole unit. The pcb's can usually be accessed with power on, but power must be secured when you remove and replace a pcb. The pcb's can be extended individually for maintenance.

The other main parts of the computer, such as the power supply unit and cooling unit, are located in a different part of the frame or cabinet, not in the cage or rack with the pcb's. Figure 2-12 is an illustration of a cage or rack setup.

Motherboard- or Backplane-Designed Computer Frames/Cabinets

Computers that use a motherboard or backplane design are built more for their portability and compactness. They are the least rugged. The frame or cabinet contains the following:

- A motherboard or backplane with the connector receptacles for each pcb, the keyboard, and in some types of micros: single inline memory modules (SIMMs), single inline packages (SIPS), and single inline pin packages (SIPPs)
- Wiring harness for the motherboard or backplane
- Pcb's with the necessary I/O connectors
- External connections for the power cables
- Retaining hardware for the motherboard or backplane
- A power supply unit
- A small fan with an air filter for cooling
- A small speaker

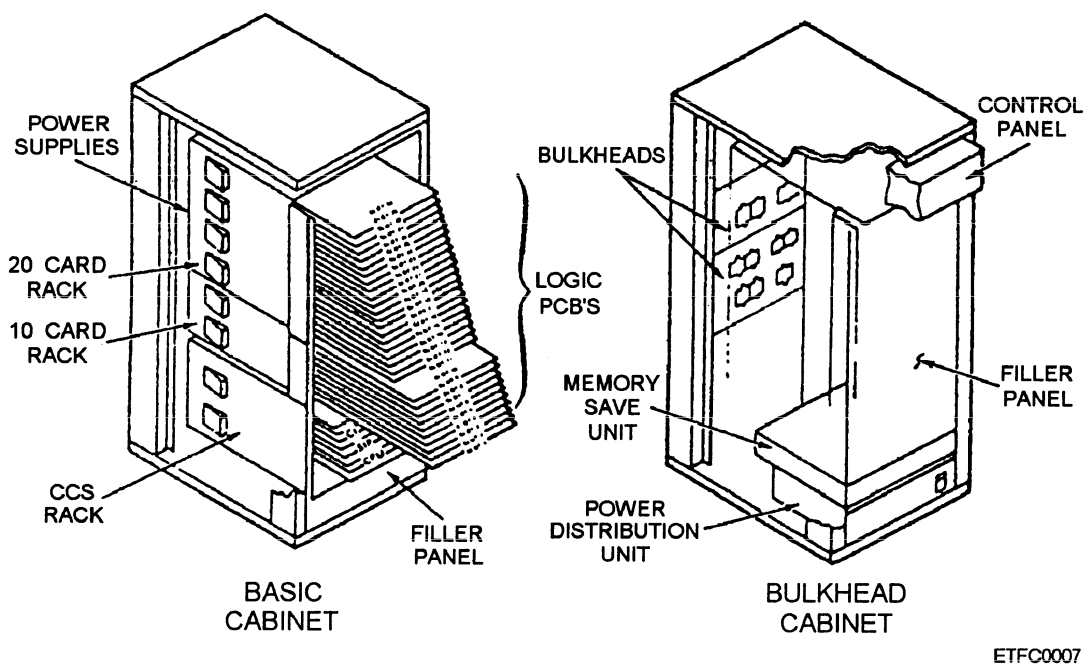

Figure 2-12.—Example of a cage- or rackdesigned computer frame or cabinet.

Also contained in the frame or cabinet of the computer is the peripheral equipment-floppy and/or hard disk units. Computers that use motherboards or backplanes use a keyboard external to the frame or cabinet as their method to control the computer. **With some micros, however, the keyboard is part of the cabinet assembly.** The motherboard or backplane usually rests on the bottom of the frame or cabinet of the computer. The motherboard or backplane contains all the pcb's for the whole computer, a keyboard connector, a battery backup circuit, and power supply status LEDs. A motherboard has IC chips included on the motherboard; a backplane does not. Each pcb contains one or more functional areas. Figure 2-13 is an illustration of a motherboard or backplane design used in a computer.

It is easier to perform maintenance on computers with motherboards or backplanes than on modular- or chassis-designed computers because of their size and the easy accessibility to the interior of the computer. Extending pcb's for maintenance is usually not necessary because everything can be readily accessed once the cover is removed; this includes maintenance with the power still applied. Remember, you must still exercise safety precautions when removing and installing any parts inside the frame or cabinet by securing power to the computer.

Safety and Security Design Features of Computer Frames/Cabinets

The frame or cabinet can provide limited protection for a computer by use of gaskets and filters. Gaskets and filters are not used on all types of computers, but they serve important safety and security functions on those where they are used.

GASKETS.— Gaskets are used for two main purposes on computers. Gaskets provide moisture sealing protection and protection against interference (radio frequency interference [RFI] and electromagnetic interference [EMI]). The gaskets are usually located around the edges of an item to protect its contents or internal parts. For example, gaskets are used in heat exchangers for a module to protect the pcb's inside the module from moisture and electronic interference. Gaskets are also used in electrical connectors inside a frame or cabinet to protect the connection from electronic interference.

FILTERS.— There are two types of filters you will encounter. They are electronic (EMI and RFI) and environmental (foreign particles such as dust and dirt) filters. Both filters provide protection for the computer. The computer's technical manual and/or the Planned Maintenance System (PMS) will provide you with the requirements for the maintenance of these two filter types.

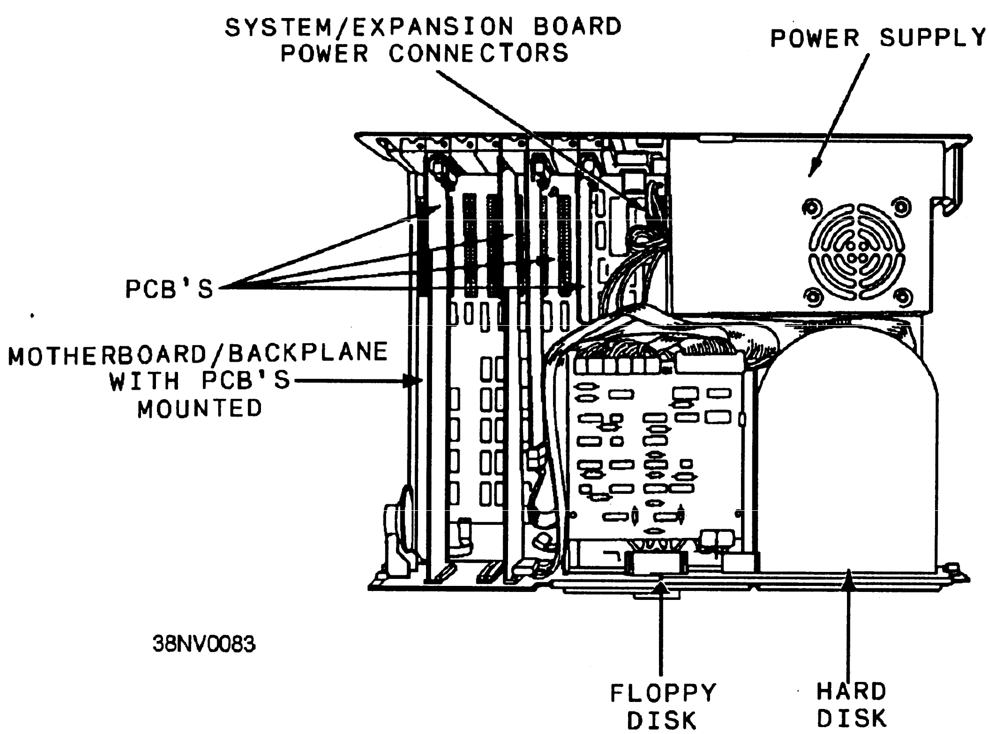

Figure 2-13.—Example of a motherboard- or backplane-designed computer.

CAUTION

DEVICES USED IN COMPUTERS ARE SENSITIVE TO ESD (ELECTROSTATIC DISCHARGE). ENSURE THAT YOU ARE FAMILIAR WITH THE COMPUTER'S SAFETY PRECAUTIONS THAT DEAL WITH ESD AND TAKE THE NECESSARY STEPS TO PROTECT THE COMPUTER. YOU CAN FIND THE REQUIREMENTS IN THE COMPUTER'S TECHNICAL MANUALS.

SUBASSEMBLIES USED IN COMPUTERS

Subassemblies are electronic parts of the computer that are a portion or part of a functional area. A subassembly can contain pcb's or just electronic parts. Two or more components combined into a unit will form a subassembly. Each subassembly can contain components, such as transistors, resistors, capacitors, and the like, and/or pcb's to make one individual subassembly.

We use a power supply module and a memory module of a large computer as our examples.

A power supply module in a large computer usually has six or seven subassemblies. Each of these subassemblies contains transformers, transistors, diodes, resistors, capacitors, and the like.

A memory module may need up to four memory stacks to make it complete. Each stack contains only the electronic components necessary to make it complete.

Some of the items you will find in subassemblies of computers are as follows:

- Memory stacks of a memory unit
- Dc-to-dc converters in modules
- Dc switching regulators of a power supply

KEYED SUBASSEMBLIES.— Subassemblies are keyed to assure that only the connect subassembly is inserted into a slot and that each subassembly is inserted properly (not backwards). The manufacturer will either cut a slot into the plug-in side of the pcb or put plastic sleeving on one or more of the connector pins. With the pin/plastic sleeving method, the connector receptacle must match the pin(s) with the sleeving to accommodate the pcb's connector pin(s). The arrangement of the subassembly's connector pins (plugs) can also act as a guide when you install the subassembly.

MAINTENANCE OF SUBASSEMBLIES.— Subassembly units can be sealed or unsealed. With the sealed units, you cannot break them down any further for repair purposes. You'll have to discard the sealed subassembly unit and replace it or turn it in for a new subassembly. A subassembly may or may not have test points for maintenance purposes.

PRINTED CIRCUIT BOARDS USED IN COMPUTERS

Printed circuit boards (pcb's) makeup the majority of the computer's functional areas. They vary in size from small pcb's used in modular designs to large ones used in some cage-or rack-designed computers. Let's take a look at the functions and physical characteristics of pcb's.

Functions of Printed Circuit Boards

It doesn't matter what type of computer we are talking about, the computer's printed circuit boards process all the data the computer processes. The pcb's contain the circuitry that electronically manipulates the data that enters and leaves the computer. The functional areas of the computer are contained on the pcb's.

Physical Characteristics of Printed Circuit Boards

The physical characteristics of a pcb depend on the type of computer. Let's examine some general characteristics.

SIZE AND NUMBER OF PRINTED CIRCUIT BOARDS.— The size and number of pcb's vary from the computers that require many small pcb's for one functional area of the computer, to the computers that need only a single medium to large pcb to handle one functional area. Take a computer's CPU as an example. Larger militarized computers may use up to 200 small pcb's to perform the functions of the CPU. Whereas a microcomputer needs only a single "chip" on a single pcb to perform the functions of the CPU; thus requiring less circuitry to perform the CPU functions.

ARRANGEMENTS OF PRINTED CIRCUIT BOARDS.— Again the type of computer will dictate the arrangement of pcb's. The computer's technical manual will provide the information on how the pcb's are arranged inside the computer's frame or cabinet. Computers that are modular in design have all the pcb's for a functional area located in one or more modules. In computers that use a chassis/assembly, cage/rack, or motherboard/backplane design, the functional areas are located on a single pcb or a group of pcb's located in a single area. The pcb's generally face in one direction whether they are used in a modular, chassis/assembly, cage/rack, or motherboard/backplane design. Some equipment provides card guides or brackets and locking or tiedown bars, so pcb's will not suffer intermittent problems as a result of shock and vibrations.

KEYED PRINTED CIRCUIT BOARDS.— Pcb's are keyed to ensure that a different card type is not inserted into a slot or the correct pcb is not inserted backwards. The manufacturer will either cut a slot into the plug-in side of the pcb or put plastic sleeving on one or more of the connector pins (fig. 2-14, frame A). With the pin/plastic sleeving method, the connector receptacle must match the pin(s) with sleeving to accommodate the pcb's connector pin(s) (plug[s]) (fig. 2-14, frame B).

COLOR-CODED PRINTED CIRCUIT BOARDS.— Pcb's are identified by numbers. Some pcb's in computers show the number(s) with color bands using the standard color code (also shown on fig. 2-14, frame B). With the color-code technique, you can check the card number. The color code is also very convenient when you are working with groups of cards that have the same card number. Refer to NEETS, Module 19, *The Technician's Handbook,* for the standard color code.

MAINTENANCE FEATURES OF PRINTED CIRCUIT BOARDS.— Some pcb's have indicators and test points that are very helpful when you perform maintenance.

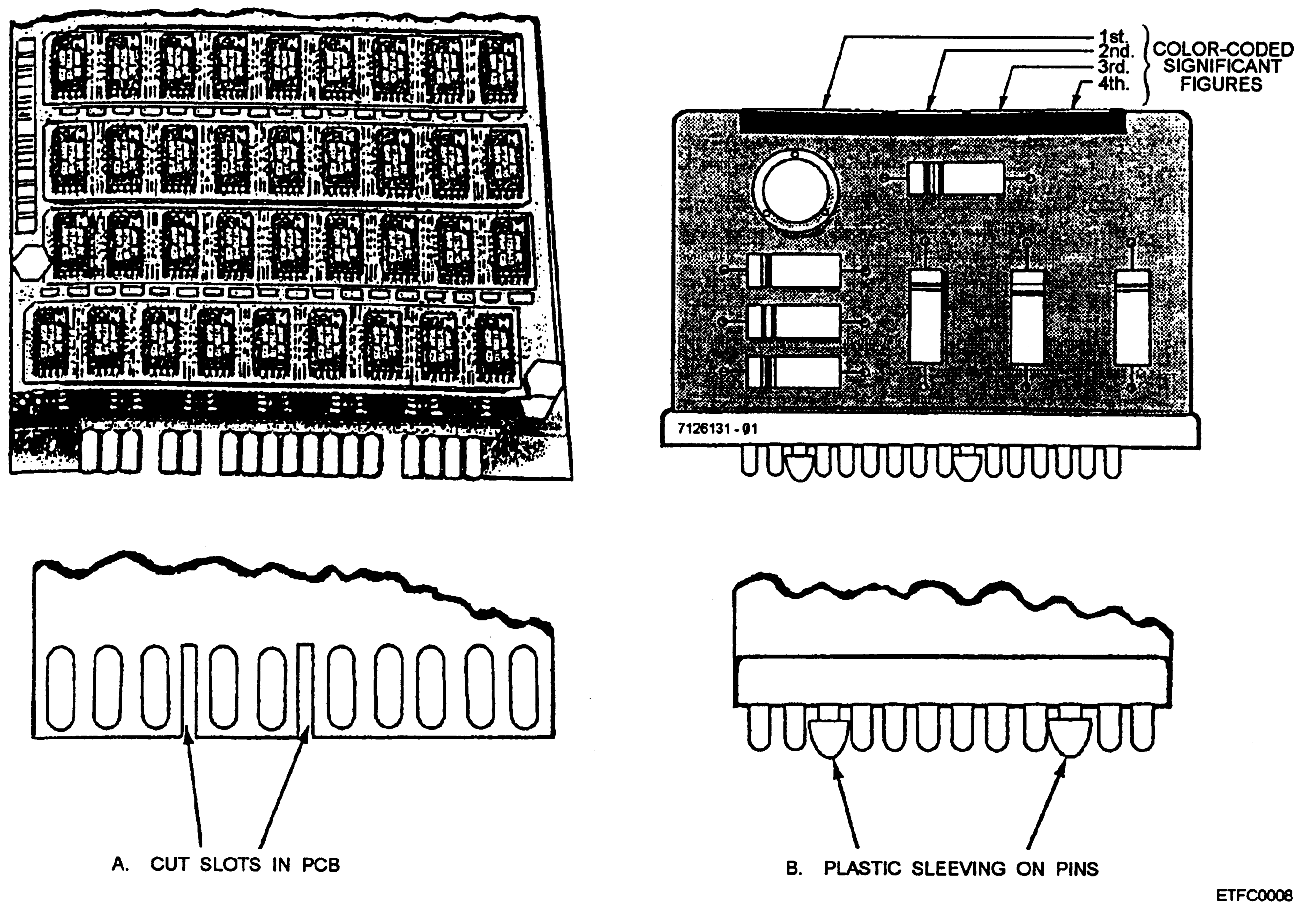

Figure 2-14.—Keyed pcb's: A. Cut slots on a pcb; B. Plastic sleeving on pins.

Maintenance Indicators or Diagnostic Light-Emitting Diodes (LEDs).— Maintenance indicators or LEDs provide you a readily visible indication to tell you when the equipment is operating normally and when it is operating abnormally. Refer to your computer's technical manual or owner's manual for their locations and operation.

Test Points.— Test points are usually located on the outer edge of pcb's. They can provide you with status or operational information with voltage levels and/or waveforms. Refer to the computer's technical manuals for details.

COMPUTER CONNECTORS AND CABLES

Computers must have an organized way to exchange and route data and power signals internally and externally. Computers must have a place where the signals leave the computer externally and talk to other computers and/or other equipments, peripherals, displays systems, and/or communication systems. The computer's technical manual or owner's manual provides parts replacement information, recommended tools and test equipment, internal and external signal distribution, and I/O interface. The following documents also provide information useful in the maintenance of computer connections and cabling. They define the standards and specifications of the interface(s) that the computer uses as well as the standards and specifications of the actual repairs to the internal and external connectors and cables.

- MIL-STD-2000, *Standard Requirements for Electrical and Electronic Assemblies*— Provides associated standards and specifications that can be used when making solder repairs to connectors and their conductors. MIL-STD-2000 provides the standards for the actual solder terminations.

- MIL-STD-2036, *General Requirements for Electronic Equipment Specifications*— Provides a list of the standard external interfaces; parallel and serial interface formats and metallic and fiber optic cabling. The interfaces listed in MIL-STD-2036 define the requirements of each standard: mechanical, electrical, functional, procedural, and any other requirements that do not fall into any of the four listed categories.

- NEETS, Module 4, *Introduction to Electrical Conductors, Wiring Techniques, and Schematic Reading*— Provides information on conductor and cable (includes coaxial) architecture and characteristics, wiring and repair techniques, and signal interpretation and distribution.

- NEETS, Module 19, *The Technician's Handbook*— Provides connector and cable information; references, types and construction/description, general application data, identification, and insert arrangement.

- NEETS, Module 24, *Introduction to Fiber Optics*— Provides fiber optic theory and operation and connector and cable information.

- EIMB, *Installation Standards*, NAVSEA 0967-LP-000-0110— Provides connector and cable information; references, identification for interpretation and distribution, and installation and repair (includes MIL-STDs of specialized tools).

- Naval Shore Electronics Criteria, *Installation Standards and Practices*, 0280-LP-900-8000 — Provides connector and cable information; references, identification for interpretation and distribution, and installation and repair (includes MIL-STDs of specialized tools).

- *Miniature/Microminiature (2M) Electronic Repair Program*, NAVSEA TE000-AAA-HBR 010/2M, Vol. 1; 020, Vol. 2; 030, Vol. 3 —Provide the same type of information as MIL-STD-2000 concerning solder repairs to a connectors and their conductors.

Remember, when making repairs to the connectors and cables, use identical replacement parts or suitable substitutions. This is very important. Let's start with the computer's internal connectors, then external connectors, and finally the cables.

Connector Architectures

In electronics, connectors are designed to terminate pcb's, conductors, and cables between electronic circuits within a system, between systems and subsystems and their power sources. Connectors interconnect circuits on circuit boards with backplanes/backpanels, motherboards, or wiring within a frame or cabinet of a computer (set). Connectors also terminate the cables interconnecting the external equipment and the computer. They come in many shapes and sizes. The interfaces listed in MIL-STD-2036 dictate the requirements needed for connectors. A connector consists of a connector receptacle (jack) and a connector plug (fig. 2-15). The receptacle can be located at the end of a cable or mounted stationary. The plug can be located at the end of pcb or cable. The actual connection (mating) of a connector consists of pcb card-edge, electrical pins (flat or round) and contacts, or soldered (wire to card-edge connector). Let's examine the types of connectors.

SINGLE-PIECE PCB OR CARD-EDGE CONNECTORS.— Single-piece pcb or card-edge connectors are used internally. They are the most widely used connectors for making connections from a pcb (plug) to a receptacle; cable, another pcb, or a larger item such as a backplane receptacle. Figure 2-16 shows a single-piece pcb or card-edge connector. Connection can also be made from the pcb edge to a wire (soldered). Terminations of conductor to receptacle include solder and solderless (wire wrap, crimping, pin removal and insertion, or Mass-Termination Insulation Displacement Connection (MTIDC) or Insulation Displacement Connection (IDC).

TWO-PIECE PLUG AND RECEPTACLE PCB CONNECTORS.— Two-piece plug and receptacle pcb connectors are used internally. Two-piece pcb connectors are basically the same as one-piece pcb connectors except the pcb is designed with a plug (male or female) on the card edge that plugs into a receptacle (male or female). Pins or contacts located on either receptacle or plug can be flat or round. See figure 2-17. Two-piece connectors are preferred over one-piece because they provide more resistance to shock and vibration. Terminations of conductor to receptacle

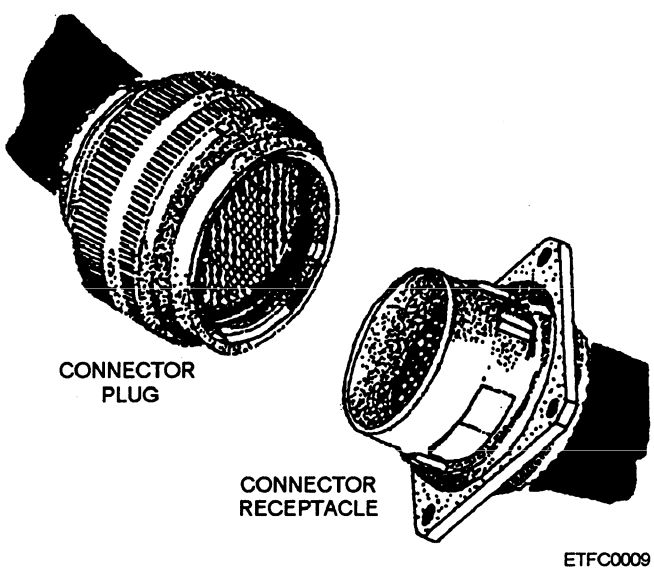

Figure 2-15.—A connector: a plug and a receptacle.

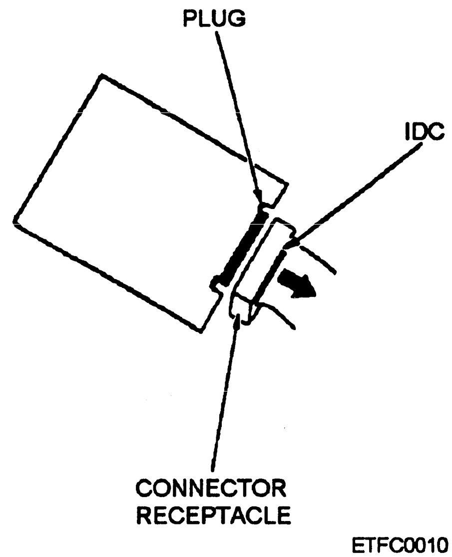

Figure 2-16.—Single-piece pcb or card-edge connector.

include solder (2M or basic) or solderless (wire wrap, crimping, pin removal and insertion, or MTIDC or IDC [fig. 2-18]).

RECTANGULAR MULTIPIN CONNECTORS.— Rectangular plastic- or metal-shell receptacles and plugs can be used for internal and external connectors. They can be flat with a single row

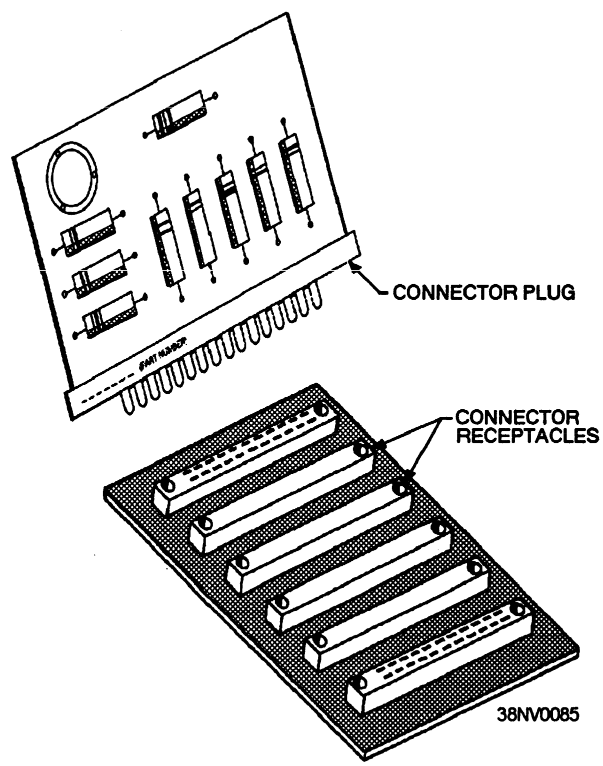

Figure 2-17.—Two-piece plug and receptacle pcb connector.

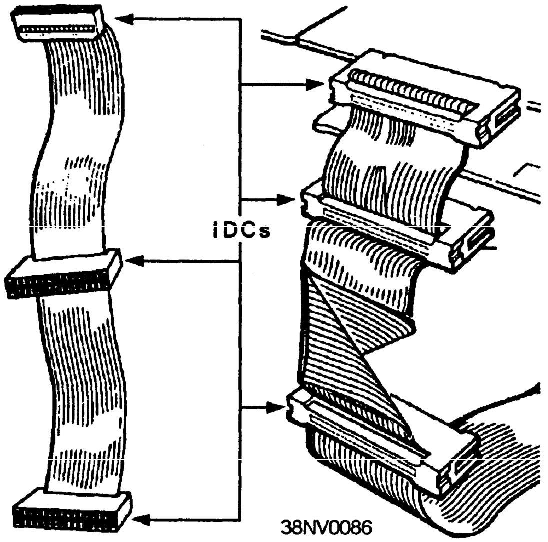

Figure 2-18.—Insulation displacement connection (IDC).

of conductors or have multiple rows of many conductors (fig. 2-19). Rectangular connectors can have over 100 pins or contacts. Contacts or pins located on either the receptacle or plug can be flat or round and can be male or female. Hardware is used to secure the connection to provide more stability against shock and vibration. Telephone jack connectors can be used to connect the conductor to a rectangular multipin connector. This is very useful in microcomputers; it makes it easy to disconnect and connect connectors.

Externally, provisions can be made for shielding these connectors from EMI and RFI. Terminations of conductor to receptacle include solder (2M or basic) and solderless (wire wrap, crimping, pin removal and insertion, MTIDC or IDC, and AMP TERMI-POINT). Terminations of conductor to plug include solder (2M and basic) and solderless (crimping, pin removal and insertion, and MTIDC or IDC). Combinations of termination are often used (fig. 2-20). For example, to secure a conductor to a connector receptacle pin or contact; it may be crimped or soldered, and then inserted into the connector receptacle.

CIRCULAR OR CYLINDRICAL (SHELL) MULTIPLE-PIN CONNECTORS.— Circular plastic- or metal-shell receptacles and plugs can be used

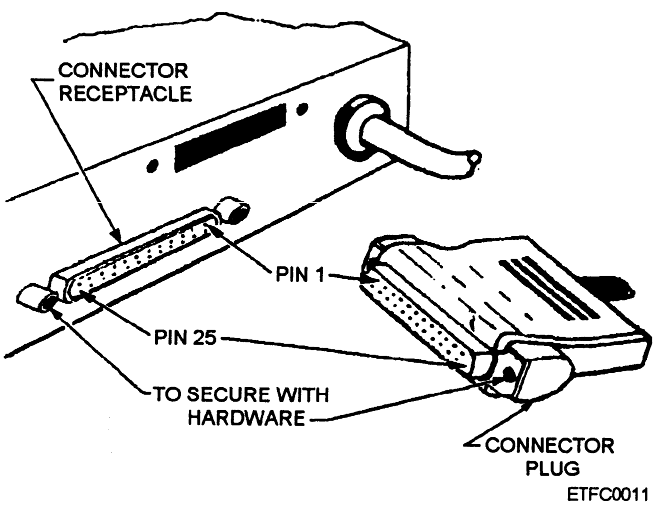

Figure 2-19.—Rectangular multipin connectors.

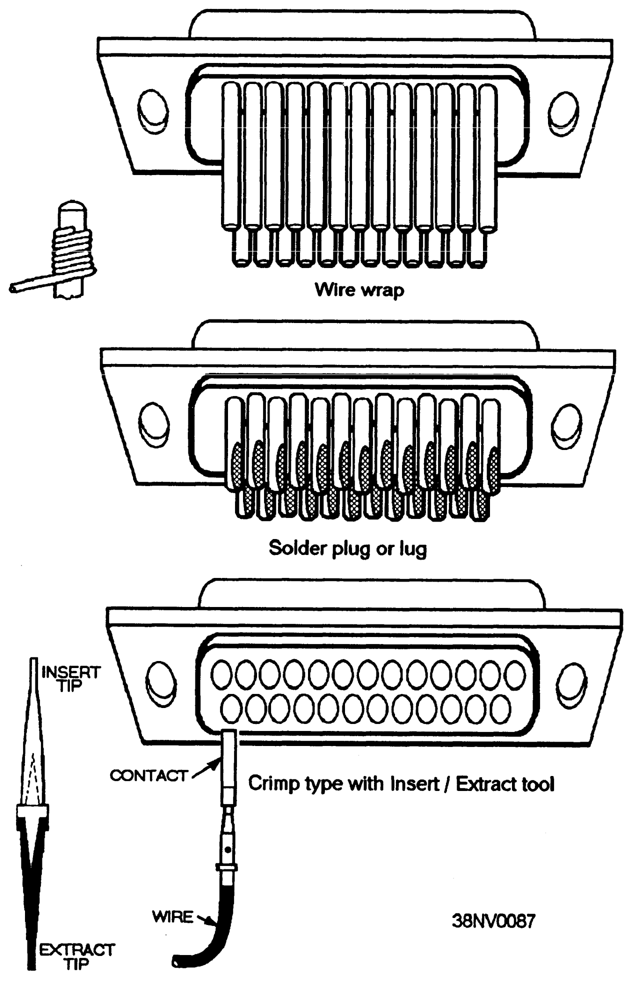

Figure 2-20.—Combination of various terminations.

for internal and external connectors (fig. 2-21). Circular connectors can have over 100 pins or contacts. The contacts or pins located on either the receptacle or plug are usually round and can be male or female. Circular connectors can be secured to protect against shock and vibration with either complete or partially threaded shells (breech lock) or bayonet-style (pin and curved slot); neither kind requires internal or external screws for securing the mating parts.

Externally, provisions can be made for shielding these connectors from EMI and RFI. Terminations of conductor to receptacle include solder (2M or basic) and solderless (wire wrap, crimping, pin removal and insertion, MTIDC or IDC, or AMP TERMI-POINT). Terminations of conductor to plug include solder (2M and basic) and solderless (crimping and pin removal and insertion). Combinations of termination are often used.

Fiber optic connectors fall into the circular connector category. Refer to NEETS, Module 24, *Introduction to Fiber Optics,* for a discussion of the mating of fiberoptic connectors.

COAXIAL CONNECTORS.— Coaxial connectors are designed for single, twin (twinax), and triple (triaxial) conductors (fig. 2-22). Refer to MIL-C-17 for connector specifications. Contacts or pins located on either the receptacle or plug are round and can be male or female. Coaxial connectors are secured bayonet-style (pin and curved slot) to protect against shock and vibration and for quick removal and replacement.

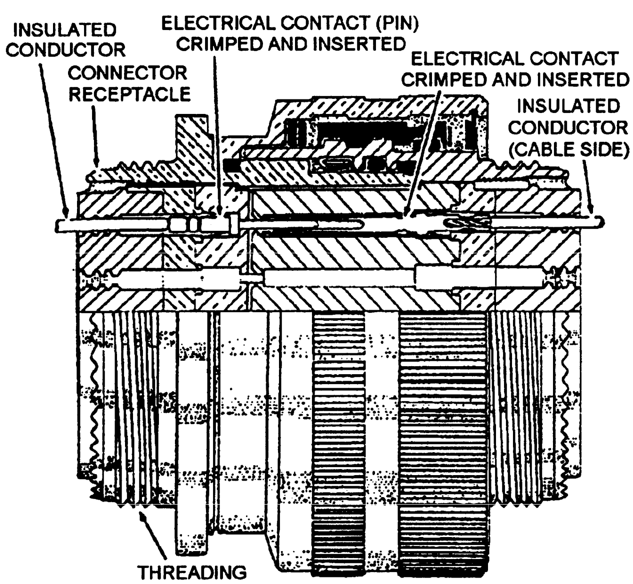

Figure 2-21.—Circular multipin connector.

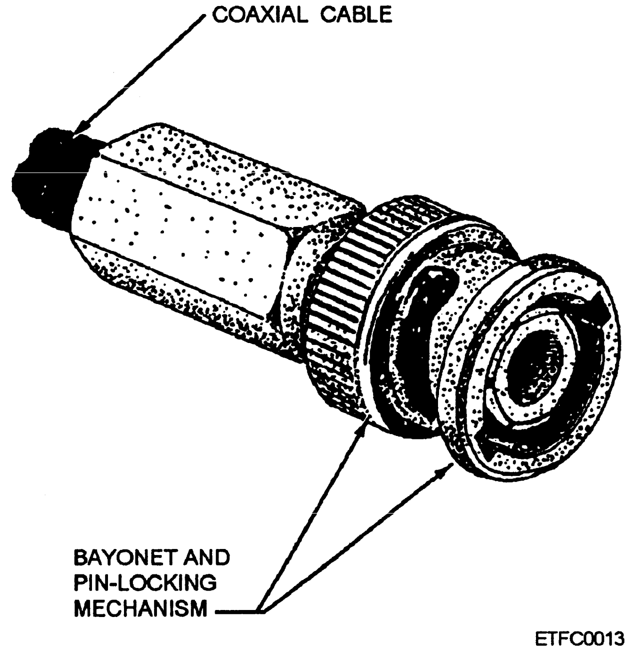

Figure 2-22.—Coaxial connector.

Externally, provisions can be made for shielding these connectors from EMI and RFI. Terminations of conductor to receptacle include solder (2M or basic) and solderless (wire wrap, crimping, and pin removal and insertion). Terminations of conductor to plug include solder (2M and basic) and solderless (crimping, and pin removal and insertion). Combinations of termination are often used.

COMPONENT CONNECTORS.— Although we may not think of it as a connector, a wire attached to a component's lead also forms a connection. The most commonly used methods of securing a wire to a component's lead are soldering and wire wrapping. For example, pushbutton indicators use wire wrap connections to secure a conductor(s) to its pin(s). Wire wrapping is often preferred because it is quick to remove and install, and it is strong. Also, you do not have to apply heat to the conductor. This prevents damage to the conductor's insulation that can be caused by using a soldering iron.

Internal Connectors

Rather than have wires running everywhere inside the computer frame or cabinet and between the units, various methods are used to connect the conductors from point to point and to organize the conductors.

Connectors are used inside the computer to interconnect the major individual units of the computer. Individual conductors are used to route each signal between the connectors of the major units and to provide power throughout the computer. For example, we want a signal to go from a CPU module or pcb to a memory module or pcb. A signal will leave the CPU at its plug, which is plugged into a connector receptacle. A conductor will route that signal from the CPU's connector receptacle to the memory's connector receptacle, where the signal will go from the connector plug to its destination inside a memory module or pcb.

INTERNAL CONNECTOR RECEPTACLES.— Internal connector receptacles receive the connector plug of an individual unit (module, subassembly, or pcb) or wiring harness. Connector receptacles can have male or female electrical contacts. The sizes and shapes of the electrical contacts vary. Refer to your computer's technical manual for details. Receptacle connectors are used in the following places:

- Frame or cabinet to receive a module or **wiring harness**
- Module to receive a subassembly or pcb
- Chassis or assembly to receive a subassembly y or pcb
- Rack or cage to receive a pcb
- Motherboard or backplane to receive a pcb

Examples of connector receptacles are illustrated in figures 2-23 and 2-24. Figure 2-23 shows the connector receptacles of a module for receiving pcb's. Figure 2-24 illustrates the connector receptacles of a motherboard.

INTERNAL CONNECTOR PLUGS.— Individual units and wiring harnesses will have a plug that connects into an internal connector receptacle. Again depending on the design, the plug can have male or female electrical contacts. The connector plugs on the following units will be plugged into connector receptacles:

- Module
- Subassembly
- Pcb
- Wiring harness

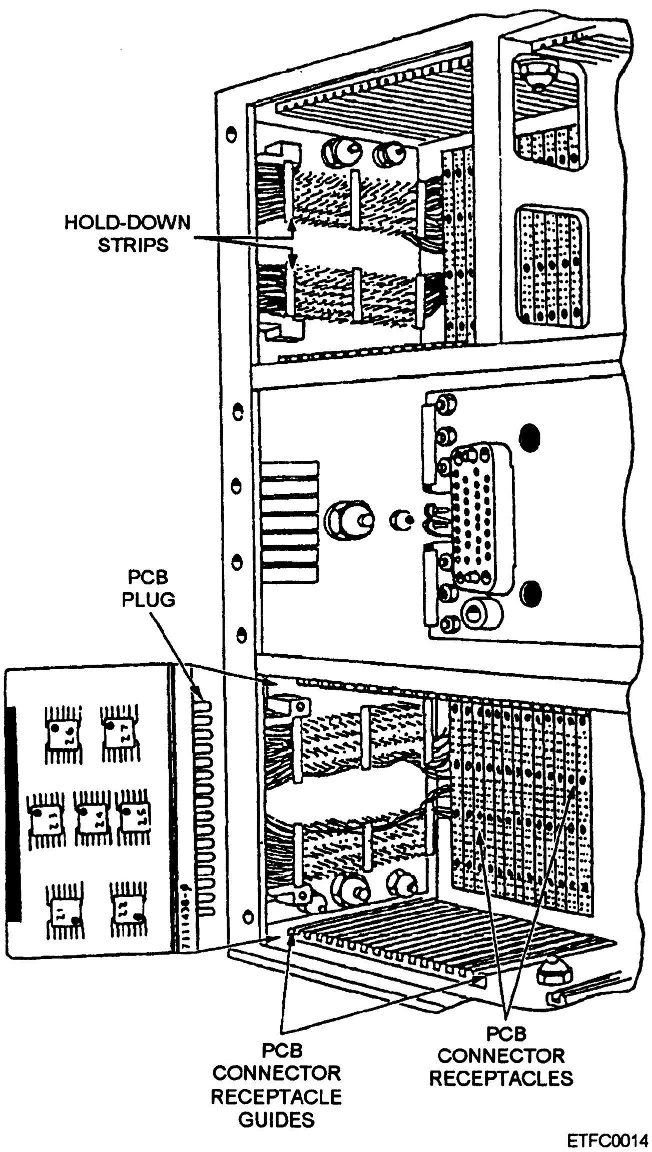

Figure 2-23.—Connector receptacle of a module for a pcb.

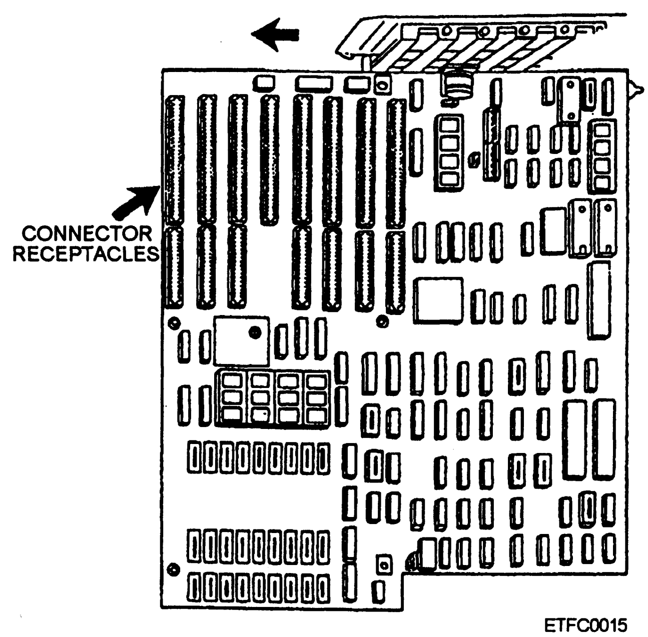

Figure 2-24.—Connector receptacles of a motherboard.

Remember that internal connector receptacles and plugs are keyed for each other; or in some cases, they will have guide pins. The receptacle and the plug must match to be connected properly. Pay attention to this because you can cause extensive damage if the connection is reversed or if you force the connection. Also, remember that connections should be made with the power secured to the computer.

INTERNAL CONDUCTORS (WIRES).— The wires will take individual signals or mass data and route them for distribution throughout the computer. Signal names used by a computer can be found in the wire listings, computer prints, or the description of each pcb. Learn to interpret the computer's wire listings and prints. This skill will prove invaluable when you have to trace signals from point to point when diagnostic testing does not prove conclusive in finding malfunctions. To find information on how to interpret signals and signal distribution, look in the computer's technical manuals. The wires can be connected between two plugs, between two receptacles, between a receptacle and a plug or vise versa, or they can originate and terminate on the same receptacle, plug, or indicator/switch. They are used in every part of the computer and any type of computer. The following are some examples of where conductors are terminated:

- Wiring harness plugs
- connector receptacles of a modular frame or cabinet
- Between a connector receptacle and a plug inside a module
- Connector receptacles inside a chassis-, assembly-, rack-, or cage-designed frame or cabinet
- Connector receptacles of a motherboard or backplane
- Indicators and switches throughout the computer
- External connector receptacles

Conductors used internally in a computer are insulated with a plastic coating. Be careful when making repairs. If the repair calls for soldering, the fumes from heating the plastic coating can be toxic. Remember, conductors can originate and/or terminate from or to the same connector receptacle, indicator, or switch.

Because wiring must be neatly organized, wire bundles in computers are used to route the conductors from point to point. The wire bundling method of organizing the wires is used for interconnections inside of a module, in a cage or rack, in a chassis or assembly, and inside a frame or cabinet. The wire bundles are secured by either lacing, spot tying, or self-clinching cable straps. The conductors are arranged in what is called a **wiring harness.** The wiring harness may include terminations. A wiring harness allows the wires to be neatly organized and uses the limited space more effective] y.

Figure 2-25 shows a wiring harness used inside a computer's cabinet to secure the conductors in bundles. Notice how the wire bundles of the wiring harness are secured to keep the wiring neatly organized. Figure 2-26 is an example of a wiring harness connector (rectangular) assembly. Notice the plug and the connector pins (electrical contact). The plug is used to

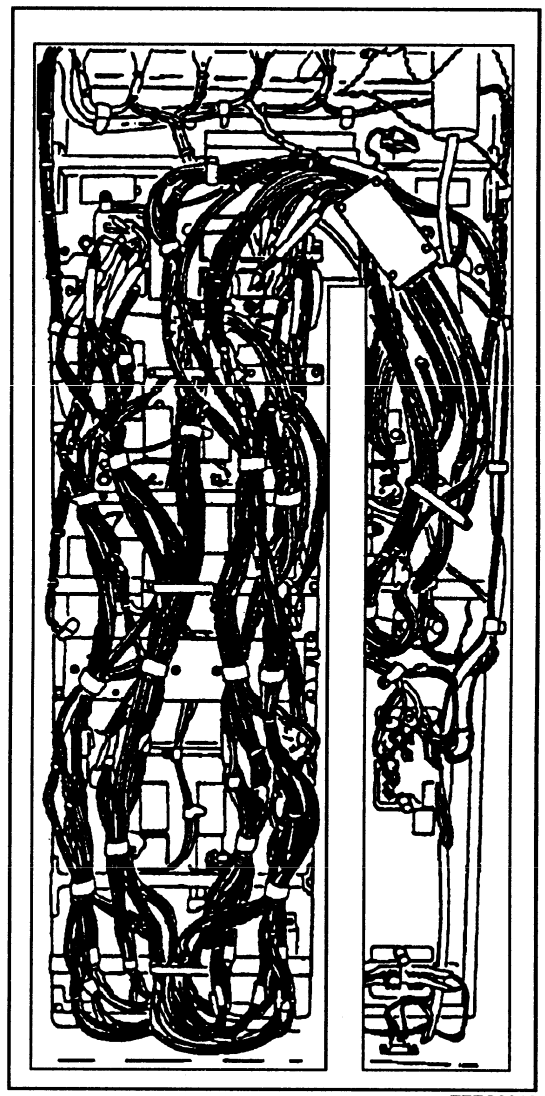

Figure 2-25.—Example of wire bundling inside a computer's cabinet using a wiring harness.

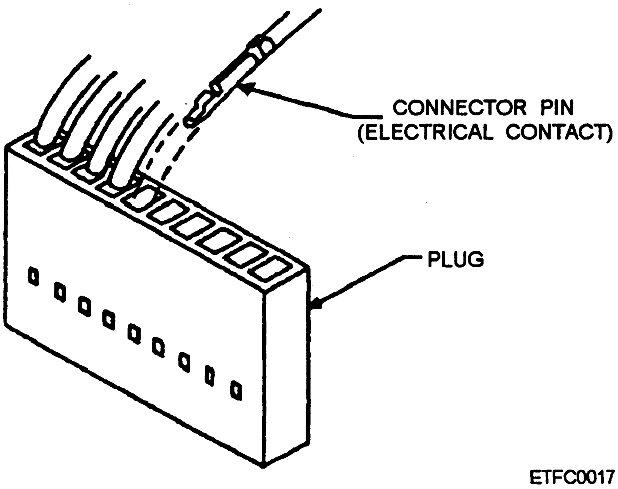

Figure 2-26.—Wiring harness connector plug (rectangular) assembly.

connect to an internal connector receptacle as part of the cabinet wiring harness.

NOTE

IF A CONDUCTOR MUST BE COMPLETELY OR PARTIALLY REPLACED, REPLACE IT WITH THE SAME GAUGE (AWG) AND TYPE OF CONDUCTOR. SEE THE TECHNICAL MANUAL FOR EXACT ORDERING AND REPLACEMENT INFORMATION.

External Connectors

The external connectors of a computer are designed to receive electrical power from power sources, send or receive data (input/output) to or from other computers or digital equipment, and to interconnect units of the same computer together. For example, the computer uses external connections to load operational programs and test programs that are stored externally on a magnetic tape unit. It also uses external connections to communicate with other computers or peripherals and/or other systems (display and/or communication). The computer's prints, wire listings, owner's manual, CSTOMs, SOMs, and/or systems doctrine or equivalent will provide the exact jack, channel or port, and pins assignments of where power and/or data enter or leave the computer.

CAUTION

WHENEVER CONNECTIONS FOR POWER AND DATA ARE DISCONNECTED OR RECONNECTED, ENSURE THAT THE POWER TO THE COMPUTER AND THE POWER SOURCE HAVE BEEN SECURED AND THE PROPER TAG-OUT PROCEDURES HAVE BEEN FOLLOWED FOR SECURING THE POWER SOURCE.

POWER REQUIREMENTS OF COMPUTERS.— The power requirements for computers vary. The requirements depend on the type of computer and/or where the computer is used-on ship or ashore. Computers are designed to accept different combinations (voltage, frequency, and phase) of primary power. A couple of examples: for a large NTDS computer aboard ship, the requirement is 115 Vac, 400 Hz, 3 phase; whereas, a microcomputer computer ashore uses 115 Vac, 60 Hz, single phase.

You need to know the primary power source for your computer system. Become very familiar with the location and operation of your computer's power source. Know the exact location of power panels in your spaces and know which circuit breakers to secure for routine maintenance and emergency situations. We discuss computer power supplies in chapter 4.

EXTERNAL CONNECTOR RECEPTACLES.— External connector receptacles receive the plug of a cable (conductor). The cables carry power and data. External connector receptacles and their plugs come in all sizes and shapes. Like internal receptacles and plugs, they, too, are keyed or because of their physical shape, can only be mated one way. Power cables and cords are fairly standard. We, therefore concentrate our discussion on some of the I/O connections used for parallel and serial data transfers. The physical shape (architecture) of these connectors does not have anything to do with the standard or the format (parallel or serial) used for the data transferred. Some of the more common series of connectors used for parallel and serial data transfer include the following:

<u>Parallel</u> —MIL-C-series—M28840, M38999, and M81511; Centronics Parallel; MTIDC or IDC; "D" series; and Nonstandard series

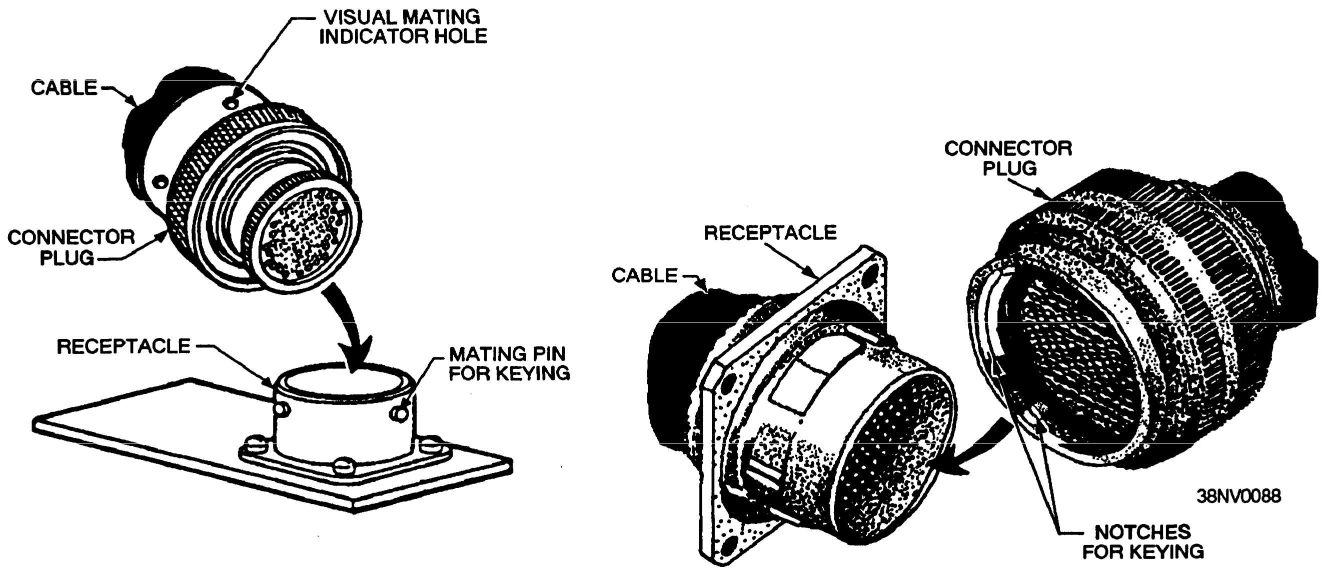

Figure 2-27.—Example of a jack keyed for a connector plug.

Serial—MIL-C-series-M28840 and M49142; MIL-C-series (fiber optics) M83522(ST) and M28876; ST 506 (fiber optics); "D" series; and Nonstandard series

Figures *2-27* and 2-28 are examples of external I/O connections that computers may use. In figure 2-27, notice that the connector receptacle (jack) is keyed; this means that the connector plug of the cable must match

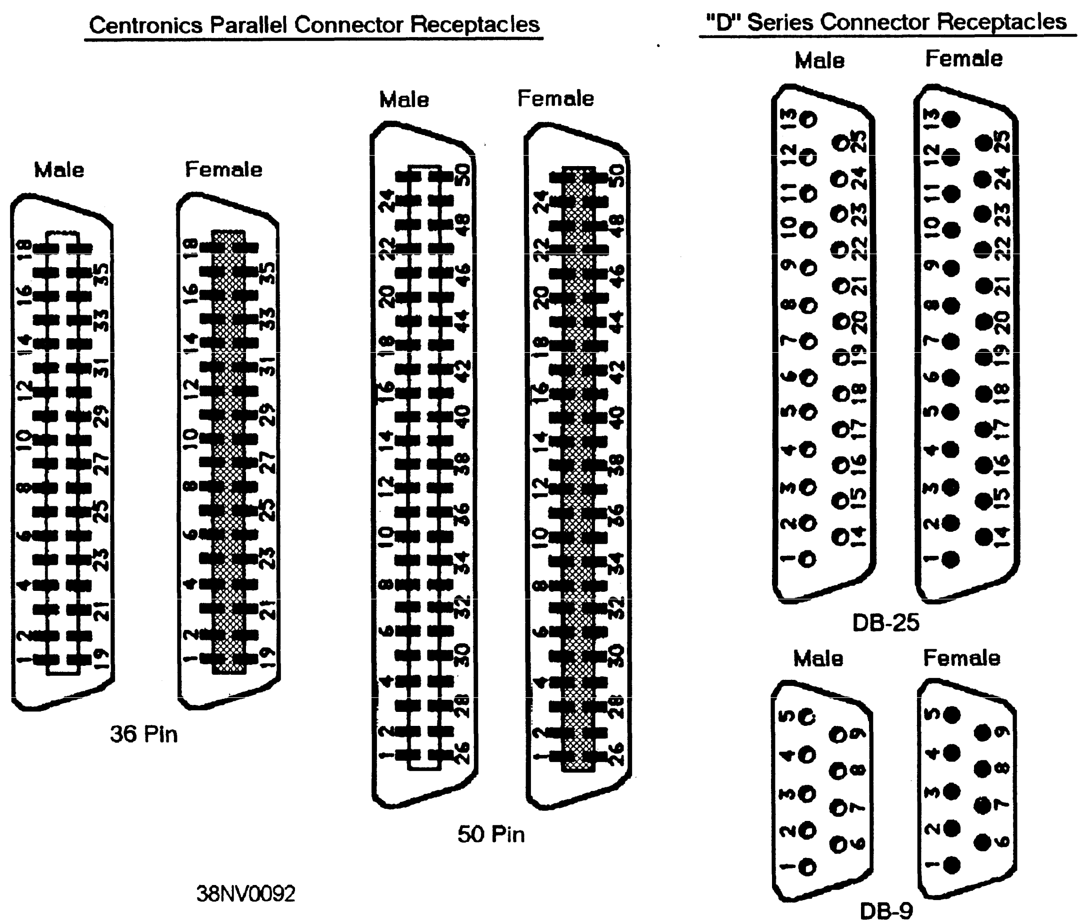

Figure 2-28.—Examples of connector receptacle physical shapes.

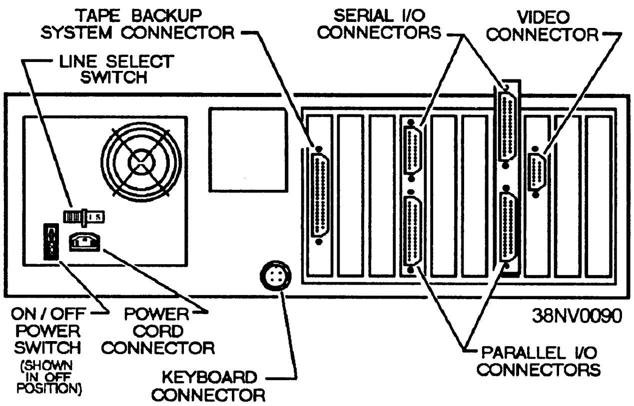

Figure 2-29.—Example of I/O jacks and other connections located on the rear of a microcomputer.

to make a connection. In figure 2-28, you'll notice that the jacks are not keyed; but because of their shapes, the connector can only fit one way.

External connector receptacles vary in location on the computer; it depends on the type of computer. However, they are usually located on the top or the rear of the frame or cabinet. Take a microcomputer for example, the I/O jacks and all other connections are located in the rear of the microcomputer. Look at figure 2-29; you'll notice the I/O jacks and other connections are located in the rear of the microcomputer's frame or cabinet. Some of the more common I/O external connectors used for the parallel and serial input/output of data are shown in figure 2-30. Notice the shape of each connector receptacle; the connector plug can only be inserted in one way.

Cable Architecture

A cable consists of two or more insulated conductors in a common jacket. Cables are used to receive electrical power from power sources, to send data to (input) or receive data from (output) other

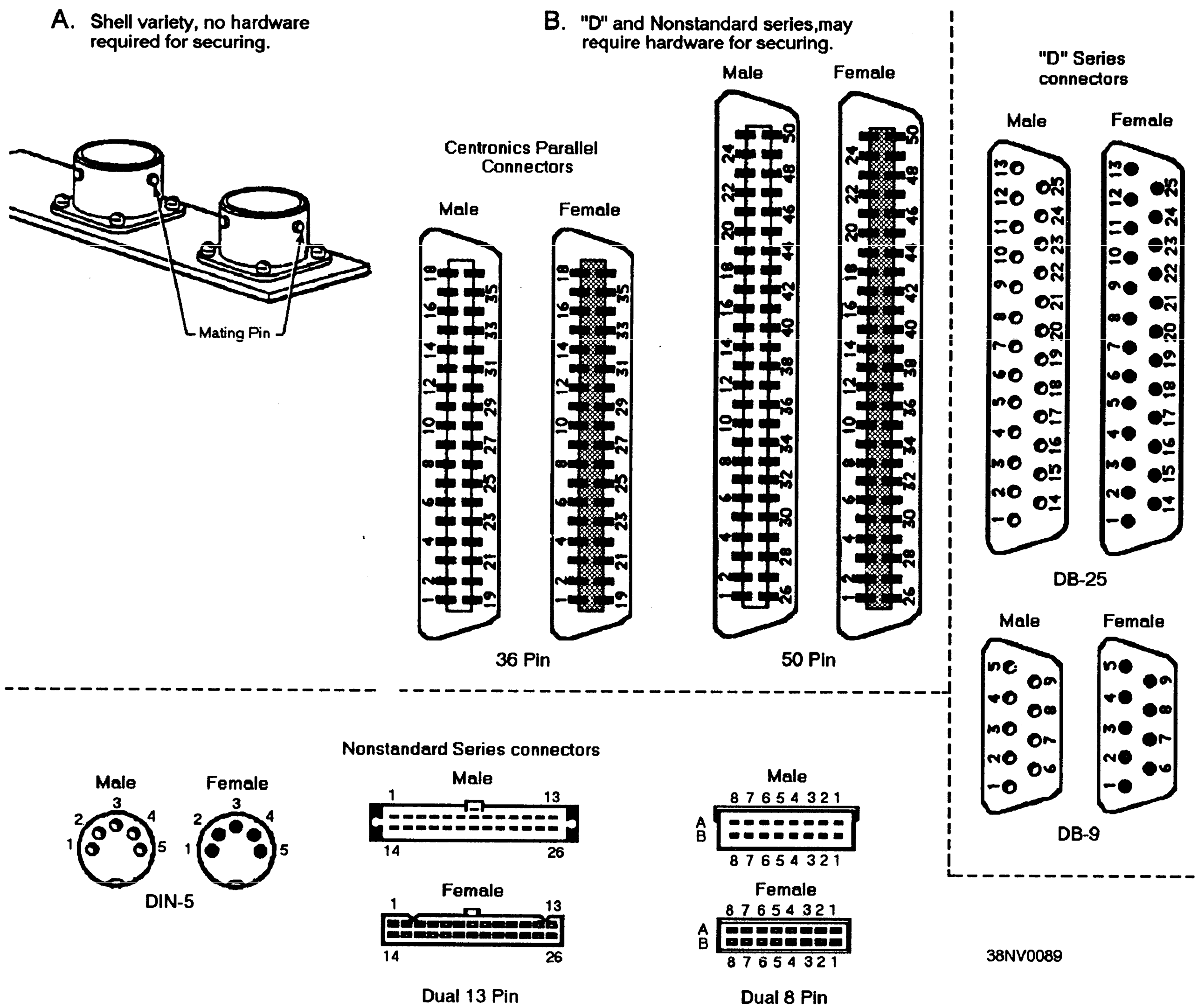

Figure 2-30.—Examples of the different types of external connector receptacles used by computers.

computers or digital equipment, and to interconnect units of the same computer together. We limit our discussion to I/O cables. The **interfacing standards** provide guidelines on the type and maximum cable length to be used for the I/O data cables. The number of conductors in each cable varies with type of computer. A cable can have from 2 to 120 conductors. The cable is grounded with a signal ground and/or to its common connector ground. If it has shielding, the shielding is also grounded to the connector (fig. 2-31). The cables must also be protected (shielded) from EMI and RFI. This is accomplished with a solid or braided covering of nonferrous conductive material, preferably copper. The cable is completely covered throughout its length. This insulated conductor or conductors provide high levels of RF attenuation to potential sources of compromising emanations (CE), such as RFI. This is not required for all cables; a shipboard environment and land-based operational sites, such as an ASWOC, are two examples of situations in which cables must be protected. We discuss some of the more common types of cables used for I/O transfer of data. They are flat, ribbon, twisted component, coaxial, and, fiber optic cables.

FLAT CABLES.— Flat cables consist of multiconductors. They can have individually insulated round conductors (solid or stranded) or bare conductors sandwiched between layers of insulation. See figure 2-32 for an example. Flat cables can be terminated with single-piece pcb or card-edge connectors, two-piece plug and receptacle pcb connectors, rectangular multipin connectors, or IDCs. They can be used for parallel and serial transfer of data. They are used extensively with microcomputers.

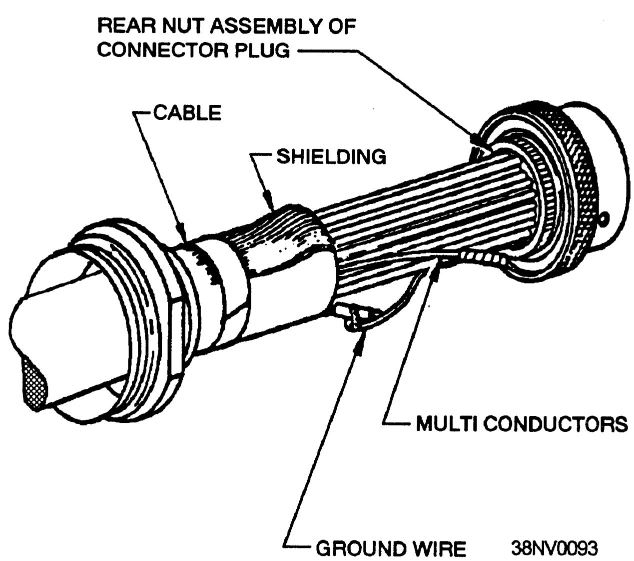

Figure 2-31.—Grounding a cable.

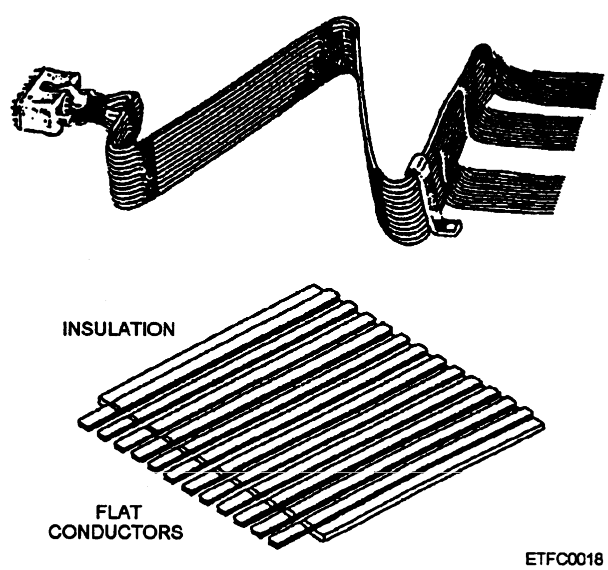

Figure 2-32.—Flat cable.

RIBBON CABLES.— Ribbon cables are flat multiconductor cables with individual insulated conductors (usually solid) that can be easily separated. Figure 2-33 is an example of a ribbon cable. Ribbon cables are extremely flexible and can be bent around sharp turns. They can be terminated with single-piece pcb or card-edge connectors, two-piece plug and receptacle pcb connectors, rectangular multipin connectors, or IDCs. Ribbon cables can be used for parallel and serial data transfer. They are also used extensively with microcomputers.

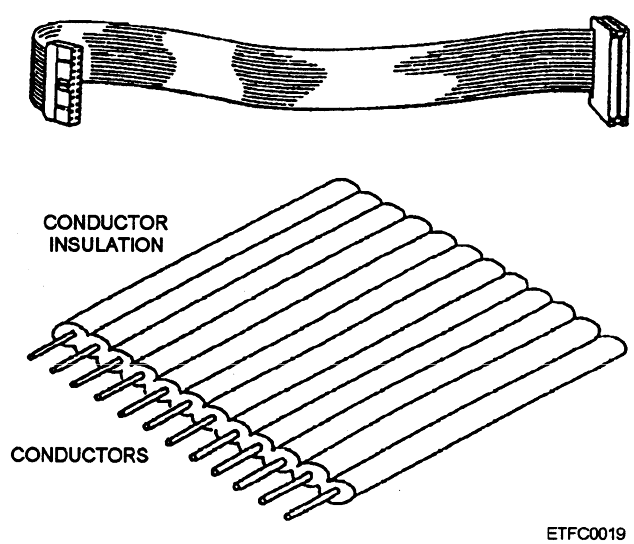

Figure 2-33.—Ribbon cable.

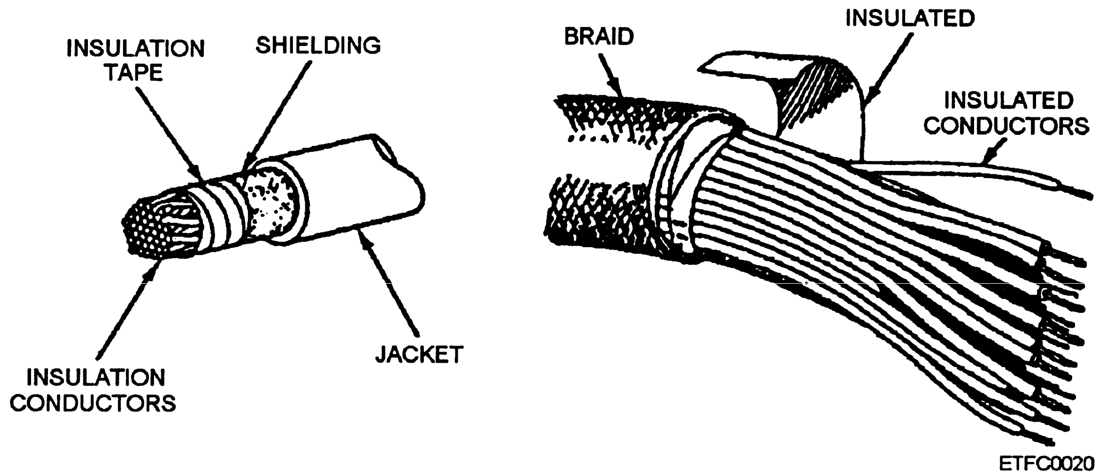

Figure 2-34.—Twisted component or multiconductor cable.

TWISTED COMPONENT OR MULTI-CONDUCTOR CABLES.— Twisted component cables consist of multi-insulated wires (solid or stranded), with up to 120 conductors. They can be single wires or twisted pairs. The cable is concentric in shape and the larger cables are usually semi-rigid to provide support and put less strain on the cable itself and its connector (fig. 2-34). Depending on the length of the cable, popular cable types for large main-frames and minis include 2U/2UW/LS2U or 2AU/2WAU/LS2AU. The construction and a description can be found in NEETS, Module 19, *The Technician's Handbook.* Twisted component cables can be terminated with rectangular multipin connectors or circular multipin connectors. They can be used for parallel and serial data transfer and in all types of computers.

COAXIAL CABLES.— Coaxial cables are designed to transmit signals efficiently between 1 kHz and 4000 MHZ with minimum loss and little or no distortion. A coaxial cable is made of a central signal conductor covered with an insulating material (the dielectric core), which in turn, is covered by an outer tubular conductor (the return path). The cable is called coaxial because the conductors, usually two or three, are separated by the dielectric core. The inner core can be solid or stranded wire that is bare, tinned, or silver coated. Coaxial cables always have an outer shielding; refer to MIL-C-17 for specifications. Commonly used coaxial cables include RG-12A, RG-58, and RG-59 for coaxial and TRF-8 and TRF-58 for triaxial. Coaxial component cables are terminated with circular multipin connectors. Coaxial cables are used for serial transfer of data. Figure 2-35 shows examples of two types of coaxial cable: single and triaxial.

FIBER OPTIC CABLES.— Refer to NEETS, Module 24, *Introduction to Fiber Optics,* for a detailed discuss of the fiberoptic cabling. Fiberoptic cables are used for serial transfer of data.

CAUTION

CARE SHOULD ALWAYS BE EXERCISED WHEN HANDLING CABLES. SEVERE BENDING AND HANDLING OF THE CABLE BY ITS CONNECTOR CAN CAUSE DAMAGE.

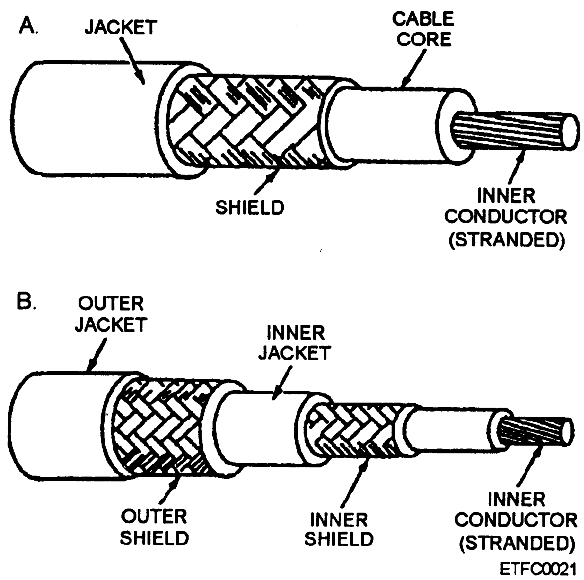

Figure 2-35.—Coaxial cable: A. **Single; B. Triaxial.**

COMPUTER COOLING SYSTEMS

The computer itself is the most critical piece of equipment in any data system. Because the contents of any computer generate a lot of heat, the computer must have a cooling system and it must be maintained at ALL times. The computer's cooling system must be operating properly to ensure the computer will operate properly. The cooling system may be air cooled, liquid cooled, or a combination of air and liquid cooled. Remember, there are four methods of cooling—convection, forced air, air-to-air, and air-to-liquid. Examples of computer cooling systems are as follows:

- Heat sinks use convection cooling to dissipate heat in computer power supplies.
- Small box fans with a filter mounted in the rear of PC/desktop microcomputers use forced air cooling.
- Heat exchangers mounted on a module, the frame, or the cabinet and air filters for blower units use air-to-air cooling. (Figure 2-36 is an example of a heat exchanger used on a large computer. Notice it is mounted on the side of a module.)

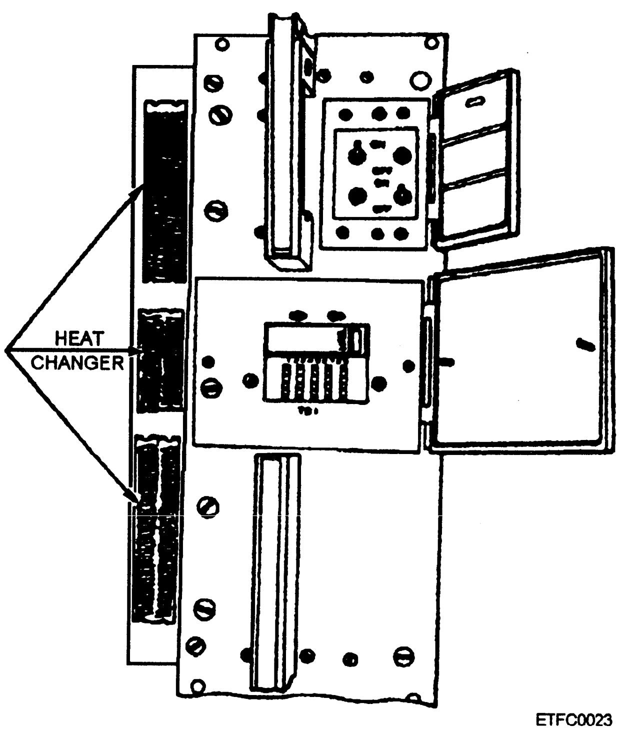

Figure 2-36.—Example of a heat exchanger used by a large computer mounted on the side of a module.

- Type III, Chilled Water/Distilled Water (CW/DW) Heat Exchanger with a CW/DW Heat Exchanger Standby is the liquid cooling system used for large water-cooled computers—primarily aboard ship.

Learn how your computer is cooled, and who is responsible for the maintenance. Remember, of the four methods, shore stations use a combination of the first three—convection, forced air, and air-to-air methods of cooling. Shipboard systems use a combination of all four method—convection, forced air, air-to-air, and air-to-liquid.

SUMMARY—COMPUTER CONFIGURATIONS AND HARDWARE

In this chapter you have studied the various diagrams and layouts used to specify computer configurations and units, the major hardware parts of a computer system, the unit connections and cables, and the need for cooling systems. The following information highlights the important points you should have learned.

FUNCTIONAL BLOCK DIAGRAMS— Functional block diagrams provide you a detailed analysis of the principles of operation or the overall equipment, types of signals and their directional flow, and the major functional areas.

FUNCTIONAL LAYOUTS— Functional layouts show the major functional areas of the computer.

PHYSICAL LAYOUTS— Physical layouts show where each element/part of the computer is located. They do not show signal/signal flow.

COMPUTER FRAMES/CABINETS— The computer is housed in a frame or cabinet. The frame or cabinet may also contain the support areas (power supply and hardware for cooling). Frames and cabinets provide some protection against hazards such as shock, EMI or RFI, moisture, and personnel mistakes.

SAFETY AND SECURITY DESIGN FEATURES— Gaskets provides moisture sealing protection and protection from RFI and EMI. Filters provide electronic (RFI and EMI) and environmental (dust and dirt protection).

SUBASSEMBLIES— Subassemblies are the electronic parts of the computer. They contain components such as transistors, resistors, and capacitors, and/or pcb's. They may be sealed or unsealed. They may or may not have test points.

PRINTED CIRCUIT BOARDS— Printed circuit boards (pcb's) make up the majority of the computer's functional areas. They contain all the circuitry that electronically manipulates the data that enters and leaves the computer. The number, size, and arrangement of pcb's varies from computer to computer. Pcb's maybe keyed to ensure they cannot be inserted incorrectly. Some pcb's are color coded. Pcb's have indicators and test points to help with maintenance.

COMPUTER CONNECTIONS— The computer must have an organized way to exchange and route data and power signals internally and externally.

CONNECTOR ARCHITECTURE— Connectors consist of a connector receptacle (jack) and a connector plug. They are designed to terminate pcb's, conductors, and cables between electronic circuits within a system, between systems and subsystems, and their power sources.

INTERNAL CONNECTORS— Connections are used inside the computer to interconnect the major individual units of the computer.

EXTERNAL CONNECTORS— External connectors receive electrical power from power sources, send and receive data to and from other computers or digital equipment, and interconnect units of the same computer system together.

CABLE ARCHITECTURE— A cable consists of two or more insulated conductors in a common jacket. Cables are used to receive electrical power from power sources, to send data to and receive data from other computers and digital equipment, and to interconnect units of the same computer.

COMPUTER COOLING SYSTEM— Cooling systems are needed because the contents of any computer generate a lot of heat.

Become familiar with the technical manuals, diagrams, and layouts for the computers you have responsibility for maintaining. Know how the computer system is configured and housed. Know the types of connections and cabling used.